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Hydrogeological Field Notes by Dr. József Tóth 1964–1969 Central and Southern Alberta

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Foreword

The following is a compilation of the field notes, sketches, and photos taken by Dr. József Tóth while working for the Alberta Research Council's Groundwater Division during his many and various field trips from 1964 to 1969. The notes were retyped from a hard copy report which was originally typed from Dr. Tóth's field notes in 1996 by Liane Schlickenrieder who was a student of his at the University of Alberta. The sketches and photos were scanned by Alberta Geological Survey staff, and the maps were digitized by GISmo Solutions. An original transcription was sought after with the intent to give the reader the perspective of Dr. Tóth's thoughts and methods during his fieldwork.

The majority of the notes were taken during the summer of 1968 along a 100 km wide corridor running from southwestern Alberta to the Saskatchewan border south of Cold Lake. Three parallel transect lines 50 km apart were drawn in a SW to NE direction on ten 1:250 000 mapsheets outlining the corridor, parallel to the structural dip of the Alberta Basin, which the majority of the field trips were conducted within. However, not all sites visited by Dr. Tóth are marked on the maps he provided for this project. Only four of the original maps were located, but a new set of maps were marked by Dr. Tóth and Liane Schlickenrieder as indicated in her 1996 introductory notes. All of the maps provided by Dr. Tóth have been included in Appendix 1. The locations of many of the stops are annotated on the maps in Appendix 1. Shapefiles were created of these annotations and released as DIG 2014-0013, DIG 2014-0014, and DIG 2014-0016. Many photos were also missing from the photo album he provided as they were used for subsequent talks and courses given by Dr. Tóth. The photos that were available are included in this report. All of the sketches which were made as part of his field reconnaissance mapping are included but are scans of photocopies as opposed to scans of originals; therefore, the clarity has been lost in some cases.

Liane Schlickenrieder typed the report as it was originally written where possible. If passages were difficult to copy and could not be verified by Dr. Tóth, they were left blank. One passage written in Hungarian regarding the flora and fauna of the Beaverhill Lake area east of Edmonton has been translated into English. There are also a few sites which Dr. Tóth revisited during subsequent field trips in 2009 and had written notes in the margin of the typed report. These notes are included in the text as bold blue type within parentheses as they occurred in the original report.

The notes and observations contained within this report were written by a hydrogeologist, hence some of the terminology used will be understood only by those with a similar background. Therefore, Appendix 2 provides a glossary with definitions for words and acronyms relating to hydrogeology. The glossary is not intended to be all-inclusive but should provide helpful clarification if needed.

Every effort was made to retain the original wording and grammar used by Dr. Tóth in his field notes both by Liane Schlickenrieder and subsequently by the Alberta Geological Survey. Landowner names and addresses have been removed for privacy protection, and there have been minor adjustments for "political correctness," but otherwise the document is as it was originally typed by Liane Schlickenrieder. The intent for keeping the text as original as possible was to capture the thoughts and observations of Dr. Tóth (from hypothesis to theory). It is truly a pleasure and unique opportunity to watch Dr Tóth's landmark "Unit Basin" theory unfold as his field observations are read.

Sheila Stewart,
May 2014

Introductory Notes

This collection of hydrogeological field notes is a transcribed version of Joe's original field notes. I've tried to stick to the original as closely as possible, simply turning the chicken scratch into a legible, handy set of notes. The few question marks still remaining in the text couldn't be cleared up even by Joe. (Needless to say, there's an excuse for each and every one of the non-legible words and nonsense phrases!) I'll leave it up to the reader to decipher the labels in the sketches, which have all been photocopied and included in this binder.

For reasons various (!) **only** those field notes taken for **Central and Southern Alberta** have been typed up and split into Sections A and B. Section A contains those notes pertaining to two reconnaissance mapping trips taken with Richard Stein during the summer of 1968, all within a 100 km wide corridor stretching from the western to the eastern border of Alberta. Section B is a more eclectic collection of notes jotted down on various short trips taken between 1964 and 1969. What has **not** been included in this book are notes on a couple of long field trips with base camps in Ft. McMurray and Ft. Vermillion, as well as several short trips to **Northern Alberta**.

Section A comes with a small selection of photographs that have been developed directly from slides. These slides were all that could be found for the 1968 reconnaissance mapping in the three black binders in Joe's office. The remaining ~80 slides may have been filed away with lecture notes and "panoramic shots" collections at home. The red binder in the office contains many 1968 prints which must have been developed a couple of decades ago. No effort was made to pull out slides for those sites in Section B. Maps! So far, we have only been able to locate four of the original 1:25 000 maps that were used in the field to mark the location of the observation stops recorded in the field booklets. These four map sheets (82O, 82N, 83B, and 83C) show the way for Part 1 of Section A. I marked up a new set of maps, copying in ink the pencil marks of the originals (with the exception of 83C; Joe had already prepared an inked version of it). Please note, some of the roads have moved and some the rivers have been dammed since 1968! Rather than folding them up and sticking them into a little pocket, all maps will remain in the map drawers.

I have had my share of fun reading some of the truly and not so truly scientific notes. More importantly it has been an educational and interesting experience to literally see hydrogeological theories develop from field observations.

August 14, 1996 Liane Schlickenrieder

Hydrogeological Mapping in Central Alberta: Rocky Mountains – Foothills – Parkland

Section A, Part 1
Field Notes

By Dr. József Tóth
July 16 to August 3, 1968

July 16, 1968

Reconnaissance trips from N. Sask. Bung. (junction of Hwy 39 – Banff Jasper – and Hwy 11 – David Thompson).

1 Along trail SWest of Hwy 11, along Cline River.
Steep mountain slope, lower parts covered with coarse, well rounded sand and gravel. General appearance is dry, although one isolated seepage was observed along the road.

Dominant vegetation is pine, mixed with some aspen, and poplar.

Between Hwy and Cline R. or N. Sask. River: on floodplains: steep gr. Terrace edges, generally dry appearance (short dry grass).

2 Hwy 11.
Steep, high mountain on west side of road. Broad floodplain. Approximately at this point the pure pine forest seems to change into spruce or mixed spruce-aspen, or pure aspen. Otherwise, area does not appear to be more moist than before.

From qualitative observation it is felt, that the ravines corresponding to indentations of the contour lines on the mountain east of the mouth of Whiterabbit Creek (Kootenay Plains) do not constitute individual groundwater drainage basins, but may be assumed to form part of the flanks of the mountain. The ravines are formed on dip-slopes:

Sketch – stop 2

3 Hwy 11.
Thick alluvium, sloping towards the river.

Vegetation is pure pine again, general appearance of valley is still dry. Underbrush is poorly developed and thin, just as it was at 1 & 2.

Direction of road is +/- perpendicular to the strike. Dip: SW.

4 Mixed pine spruce, predominantly pine. Potential mountain slope cross section.

5 Vegetation mixed spruce & pine, spruce dominating. Flood plain and slopes noticeably more moist than at previous points.

6 Hwy 11. SE slopes of Mt. Wilson
Strikingly banded vegetation on steep mountain flank. Mountain flank broad, gently and evenly sloping valley floor, which is covered by dense pine.

Potential traverse for detailed study.

Bridge: 495.0?

7 Between N. Sask. Bridge & **7**
Soil appears relatively moist. Dense, mainly spruce growth with moss ground mat. At **7** drainpipes in east bank of road. Seeps on the road side slopes.

8 Few miles (2-3) south of Waterfowl Lakes strong seeps, drain pipes.

9 Just south of rusty pebble strong seeps, potential traverse.
Warden's cabin at Bow Summit: 16.2

10 Extensive broad meadow, very moist. Water trickling out of banks.
Between 10 & Bow lake: Intensive seeps; drain pipes

11 N. side of Hwy 1: strong seeps associated with slumps; drain pipes.

12 Hwy between Stephen (B.C.) & Lake Louise: roadside spring with supersaturated clay.

13 Photos (2): very actively seeping roadside slope. Hummocky shore, spruce, drainpipes (not visible on photo)
Material: clay, sand, gravel with boulders. (At foot of Hector Mt.)

Photos 27-28

Stop 13-28

July 17, 1968

14 Highway spring
Water flows perceptibly through black top pavement over an area of approx. 5 x 4 ft. Top ½ - 1 inch portion of pavement broken off and removed. Cracks in pavement within 5-6 m from spring are kept moist. Road bank on north side of road displays very strong seeps, with moss, and actively discharging water.

Stop 14

Photos 29-31
Photos: (1 & 2) Highway spring with seeping bank in background. (3) Active seeps with Hwy spring in background.
Spring (seep) continued and controlled discharge approx. 4-5 gpm.

T1=48°F C1=190 µmohs/m
T2=55°F C2=185 µmohs/m

Vegetation on bank: mosses, horse tail, shooting star, Indian paint brush, various shrubs, spruce (Water Sample)

15 Highway spring (2 mi south of **14**)
Pavement is broken up due to upwelling water.

Photo 32
Photo: Wet breaks in pavement, pipe draining water from under pavement, roadside ditch collecting seepage water from both under pavement and road bank.
General set up is similar to that at **14**, but banks show signs of slumping.

Stop 15-34
Photos: dog lying in seepage water.

Photos 33-34

16 Seepages & Springs.

Along the trail, West of Moraine lake Lodge, on mountain side.

Large number of more or less well defined seepages, some of them springs, cover large area of the slope. (Area checked is at least 100 x 50 m).
Forest floor is covered mostly with a relatively thin, firm moss-mat.
Undergrowth consists of a variety of flowering brushes, luxuriantly growing but not dense. Forest cover is well developed, mixed fir and spruce, spruce being dominant. Several of the springs have a controlled discharge of 3 to 5 gpm.

T=47°F C=225 µmohs/m
(Water sample)

Large blocks of hard, iron speckled quartz found protruding from moss cover. Uncertain if in-situ, but probably it is.

Well developed and defined discharge channels, mostly lined with moss, indicate permanent nature of flow.

17 Spring along trail

Water discharges from bottom of stream channel, which is completely dry upstream.
Estimated discharge rate: 75-100 gpm.

T=39°F C=140 µmohs/m
More water appears between **16** and **17** than there was down slope from **16**.

18 "Fresh (üde)" mountain side.

From approximately the trail branching the mountain side becomes relatively dry. No open water, springs and seepages. The "actively decaying forest ground" (fallen moss-covered damp tree trunks, moist continuous springy moss mat, soggy spots, etc.) which is common down slope from the trail branching, is replaced here by hard, relatively dry, ground. Forest consists of good stand of spruce, with some fir, however, while trees are well developed their density is less than at **16** and **17**. Ground is kept green by short, stiff shrub.

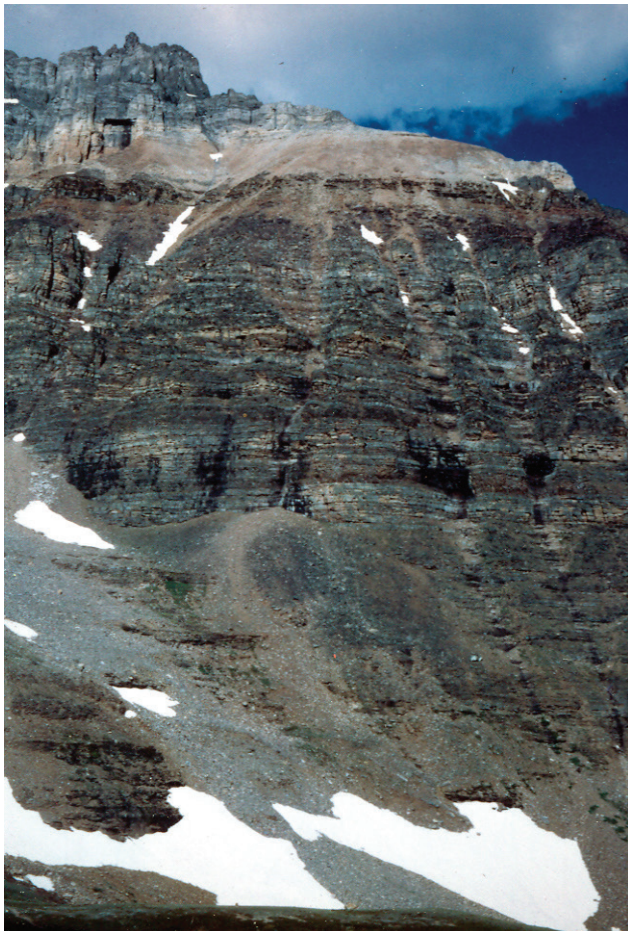
Photos 35-36

Photos: "Fresh mountain side".

19 At trail entrance to Mt. Temple valley.

Photos 37-38

Stop 19-37
Photos: Seeps on SW walls of Mt. Temple.



Stop 19-38
Photos: Seeps on SW walls of Mt. Temple.

At foot of west wall (east looking) of Mt. Temple trail valley. Alternating very hard sandstone (quartzite) and hard, thin bedded (1/2 cm) shales. Bedding is horizontal, strong joint system at 275 – 85 (magn.)

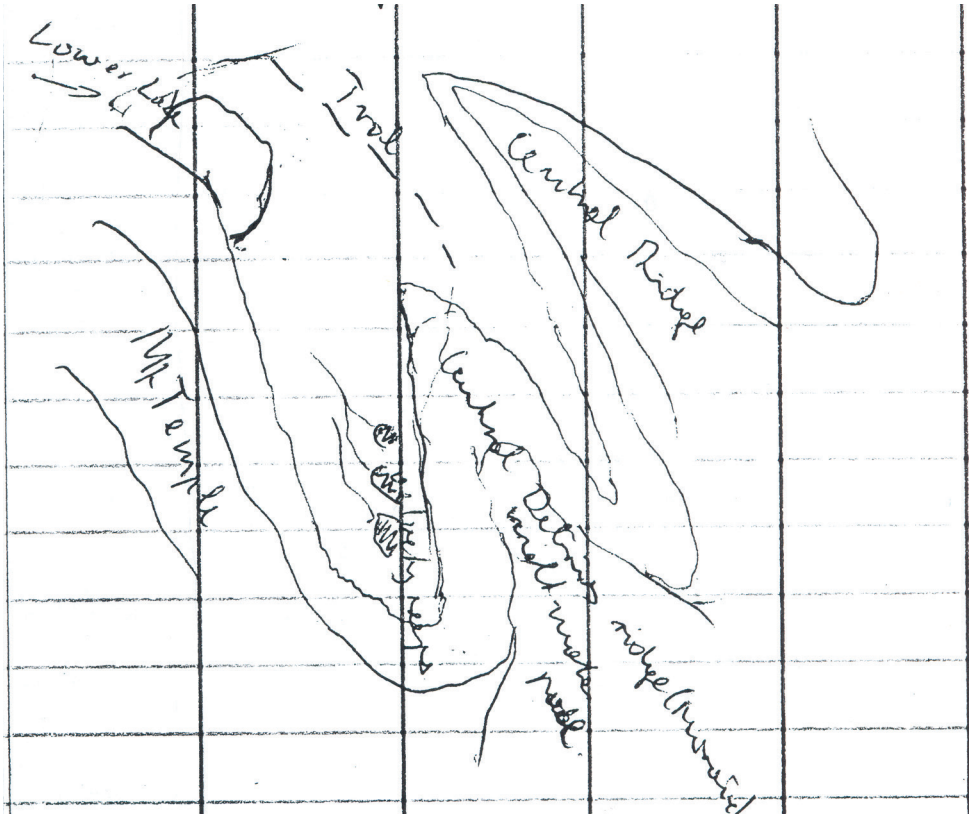
Water is seeping through joints, bedding planes and fractures. Water seeps through the bedding planes of the thin bedded shale even. Protruding ledges are dripping and planes between plates are saturated.

White salt precipitates at joints and bedding planes apparent. Various, now dry vertical black stained streaks on sheer rock face indicate one time water flow. The frequent association of these black streaks with fractures and actual seeps indicates their possible (probable) association with groundwater. Crevasses, fractures and other seeping areas harbour moss, monocotyledon and other vegetation.

Photos 1-6

Stop 19-1

Photo 1: Seepages (at visible rates) through (a) vertical fractures of thick sandstone bed; (b) bedding planes, of sandstone beds and thin shale beds, and (c) cleavage in the thin bedded shales. On sandstone ledge (with hammer) vegetation starting due to continuous moisture supply.
Photo 2 : Dripping, thin bedded shale ledge. Bedding planes are saturated; salt precipitates.
Photo 3: Light green velvety moss cover at seeps, near the crest of central ridge in centre of Mt. Temple valley. –These seepages are very similar to Marmot Creek basin seepages, and are also related to nearby recharging snow melt.
Photos 4 and 5: Distant view of "velvety seeps", with meltwater pool (Photo 6) above, which possibly could supply water to springs.



Sketch – stop 19

"Velvety seeps" T=35°F C=120 µmohs/m
"Meltwater pool" (with ice on it)T=39°F C=115 µmohs/m
Lower Lake T=48°F C=135 µmohs/m

(Water Samples: rock wall seep, velvet seeps, melt water pool)

Lower Lake, still at the entrance of the valley, but approx. 100 ft. below "velvety seeps" is a permanent body of water. Its increased C indicates groundwater contribution, which may come from both the "velvety seeps" and from Mt. Temple directly.

About at the elevation of the Lower Lake, the tamarack belt starts.

20 Entrance to trail valley

Large flat treeless meadow, with very hummocky ground surrounded by mixed tamarack-fir, first being more important. No reliable discharge features, but the freshness of the vegetation indicates a good moisture supply.

Remarks made for **18** are valid to the trail branch, which is the lower boundary of the Larch growth. This area is called Larch Valley, and has a noticeably flatter slope than that down slope from the trail branch. This change in slope may account for the change of moist (larch) to drier (see **18**) vegetation.

21 Seepage approx. 30 ft above level of Moraine Lake

T=42°F C=260 µmohs/m
(Water sample)

22 Moraine Lake water
T=45.5 °F C=165 µmohs/m
(Water sample)

23 Creek crossing road at 0.4 mi. S of Moraine Lake turn off. Discharge estimated at 300gpm.
T=40 °F C=200 µmohs/m

24 Paradise Creek at Bridge across Moraine lake road; 1.7 mi. from Moraine Lake turn off.
Area between **23** and **24** is rather fresh, with mosses, flowering shrubs, spruce mixed with some pine, horse tails, ferns, Labrador tea. On north side of bridge under the gravel bank on the road side seepage is observed. Green algae grow in it, but no sample can be taken because of rain.

Creek water T=43 °F C=130 µmohs/m

25 Large area of seeps and springs
Photos 7 – 10

Photos: Characteristic "lush" vegetation in forest discharge area, on clay, sand, gravel and boulder soil.
P***hoto 11***

Stop 25-11

Photo: Caving till road bank, collecting seep water in ditch, groundwater bubbling up through road top forming rivulet in surface, drain pipes sticking out from under the road surface, bad road top due impossibility of black surface, steepness of the valley indicating mountain side position of seepage area. (Plant specimens collected)

An approximately ___mi. stretch of the road is unpaved (no black top). The apparent reason is the instability or vulnerability of the black pavement due to the large amounts of intensively discharging groundwater.

Seep waters:
T=38 °F C=220 µmohs/m top of road 25b
T=46 °F C=260 µmohs/m bottom 25a
(Water sample, J.T. 25a, J.T. 25b)

The discharge takes place through springs and seepages, which are quite noticeable on the road bank. The top geol. formation is till. This seems to be very unstable when saturated, causing major slumps in the road cut.

Slumped material has to be removed mechanically.

First mention of recharge-discharge contrast!

Forest ground vegetation is very lush, with mosses, flowering shrubs, spruce, etc. Photos (should) indicate a definite contrast between this (discharge) site and yesterday's **18** (recharge?).

The hole dug into the till bank to enlarge and clean a seepage for sampling kept caving. Finally it produced water at a rate of approx. 2-3 gpm, with water perceptibly bubbling up from the bottom. This "bubbling up" phenomenon, usually associated with coarse sand grains dancing on top of a small underwater crater, is common at this site in the discharge channels.

Patches of open water are found on the mountain side, held up by thick moss carpet.
In summary, this area is excellent to study phenomena of mountain discharge, where the fact of groundwater discharge is in unquestionable evidence.
Photo 12

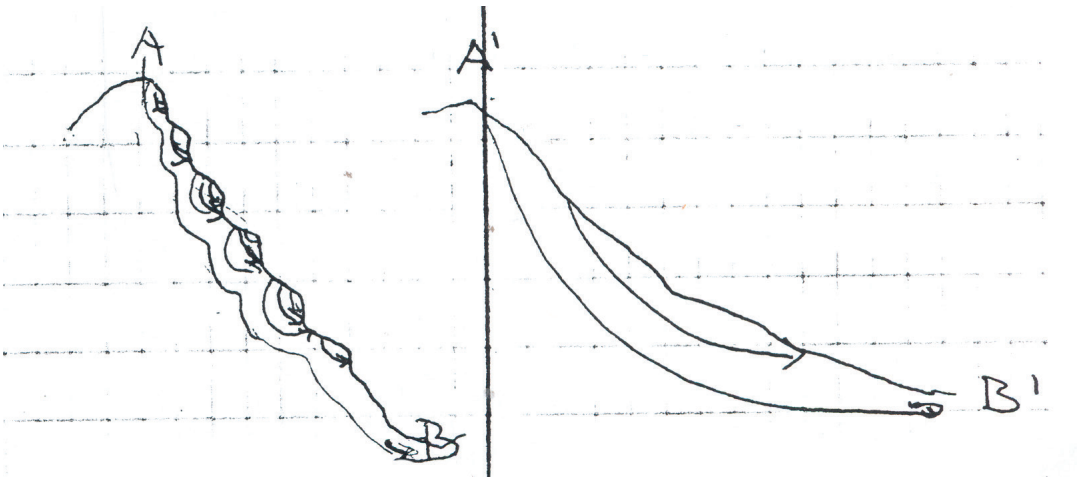
Stop 25-12

Photo: (6) Artificially enlarged-cleaned opened seep in till road cut.

Photo 13
Photo: (7) same as 5, showing now 2 sets of drain pipes (road drains)
Repeat reading at bubbling dug hole after rain:

T=39 °F C<50 µmohs/m (25b)
T=44 °F C=340 µmohs/m (25b)

Postulates:
(1) One difference between the groundwater regimes in areas of highly accentuated topography and those with less pronounced one is that the flow systems are shorter in the former one and they may surface several times on one and the same slope (mountain side) while only one system would form in a corresponding, less steep area:



Sketch – stop 25

(2) Baseflow is the closer an approximation of groundwater contribution the more pronounced is the topography. Dissected topography results in intense and concentrated discharge, which reaches the main stream subsequently in the form of perennial and rather steady contribution.

South end of hard pavement
On north side (downhill) of the road large area of seepage. Thick moss cover, almost muskeg like, with great variety of shrubs and other flowering plants and horse tails. Forest is spruce.
Seepage water:

T=43 °F C=225 µmohs/m

Seepage area appears to form, or to be situated on, a moderate terrace of the otherwise steep mountain side. This terrace may be a slump in the till, similar to those seen on the south side of the road.

Photo 14

Photo: part of the terrace, with characteristic vegetation.

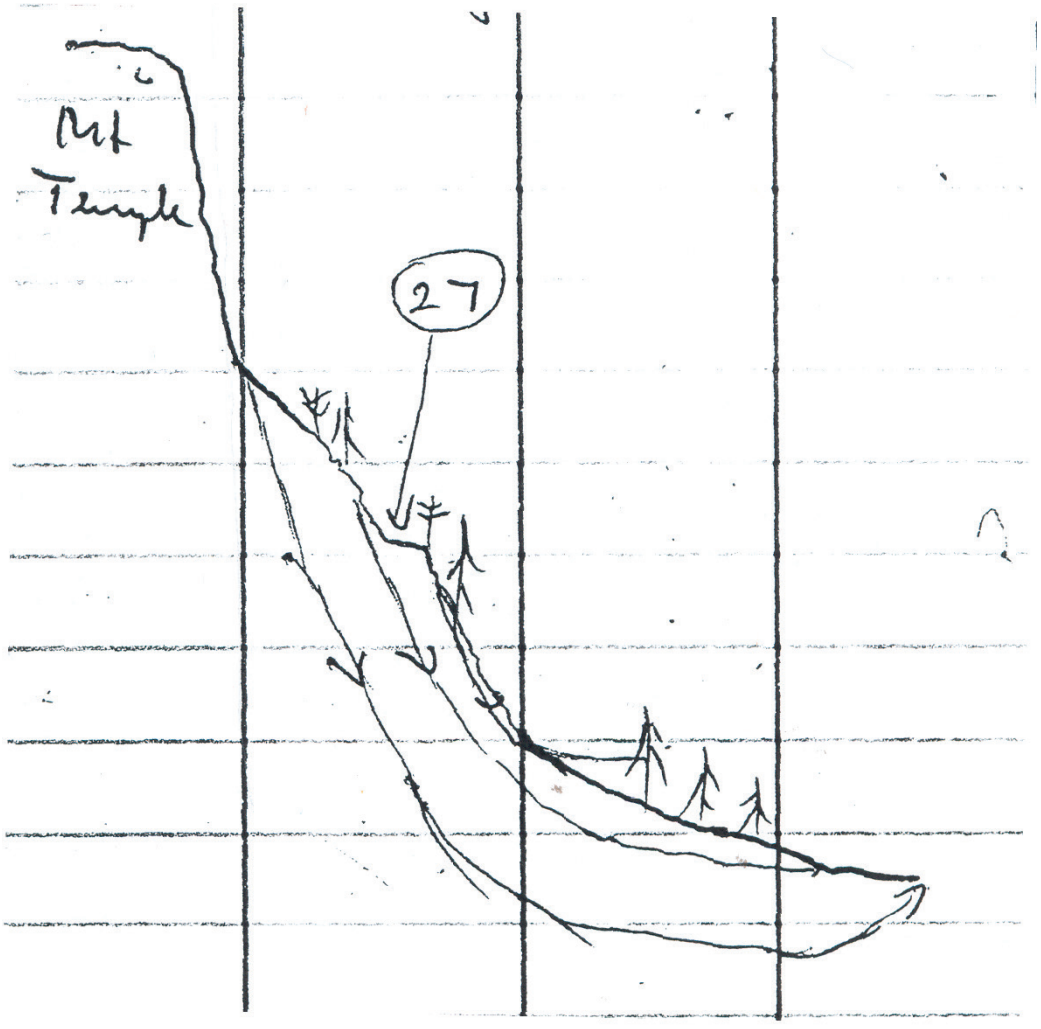
26 Seepage

Water running off the mountain side at over 10 gpm.

T=39 °F C=220 μmohs/m

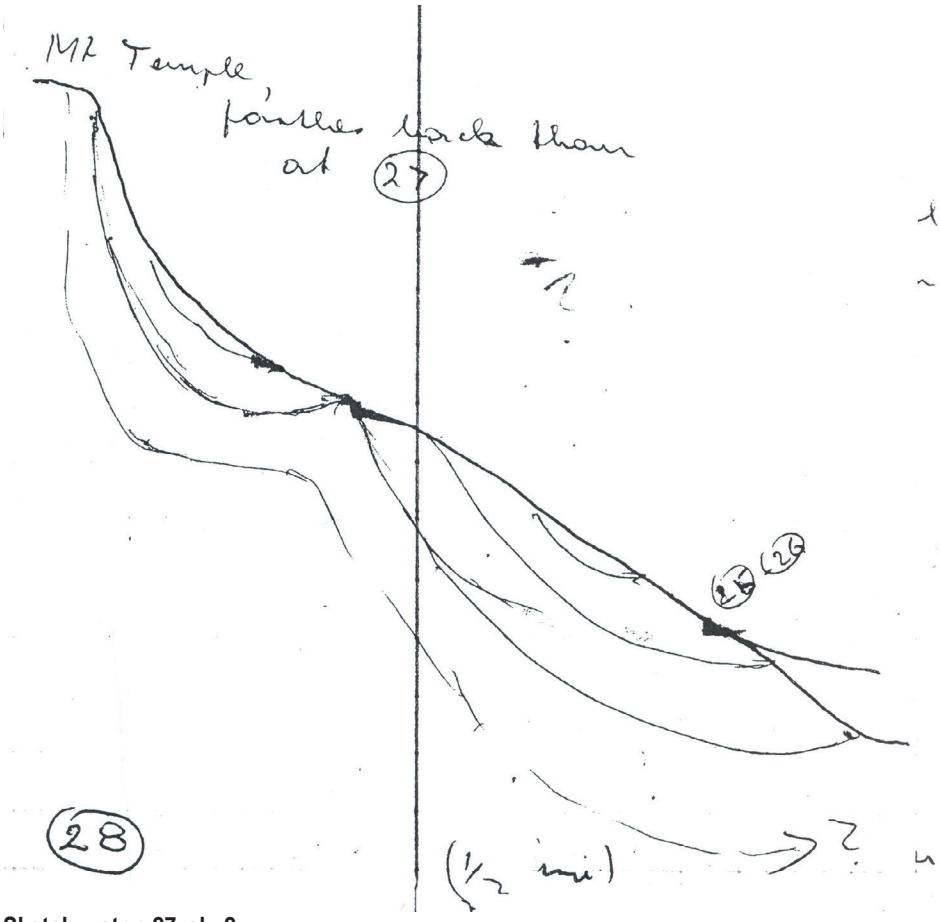
27 Dry stretch of road

This stretch of road is relatively dry, as compared with areas of stops **25** and **26**. No: seeps; slumps on the road bank despite very steep and high banks; bad pavement.
Vegetation appears less lush, although the same species appear to be present as at **25**. Pine is definitely mixed in with spruce. Farther down slope pure spruce stands appear again.
This phenomenon may perhaps be explained by the nearness of a protruding ridge of Mt. Temple, rendering this stretch a recharge or midline area:



Sketch – stop 27, sk. 1

This possibility would contrast to the seepage areas of 25 and 26, where the following situation may be hypothesized:



Sketch – stop 27, sk. 2

28 Just south of **27**

Just south of **27** (1/2 mile) seepages reoccur, with slumps, and lush vegetation. This location still has the same position relative to the protruding part of Mt. Temple as **27**, thus the above mentioned relative difference is not due to the short distance.
Conductivity values of three seepages:

T=43.5 °F C=180 µmohs/m
T=47.0 °F C=180 µmohs/m
T=49.0 °F C=210 µmohs/m

29 Seepages, springs

Very active flow, collecting in controlled discharge channels, at rates exceeding 10 gpm. Vegetation is similar to that described in connection with previous seepage areas.
Seepage water:
T=55.5 °F C=275 µmohs/m (seep into ditch)
T=47.0 °F C=285 µmohs/m (water collected into moss-channel, and rapidly flowing)

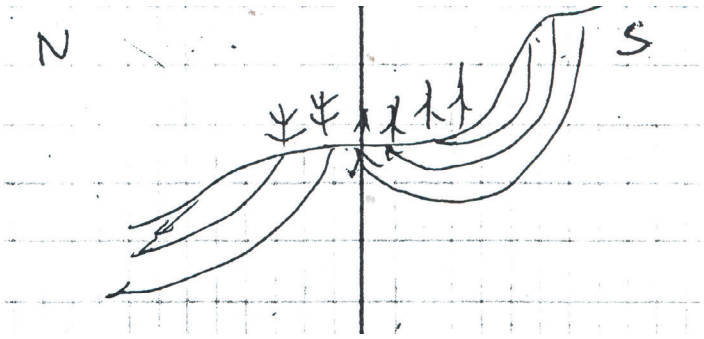
The whole stretch of road from Lake Louise junction is similar in appearance to this spot.

30 Gravel pit with deep water

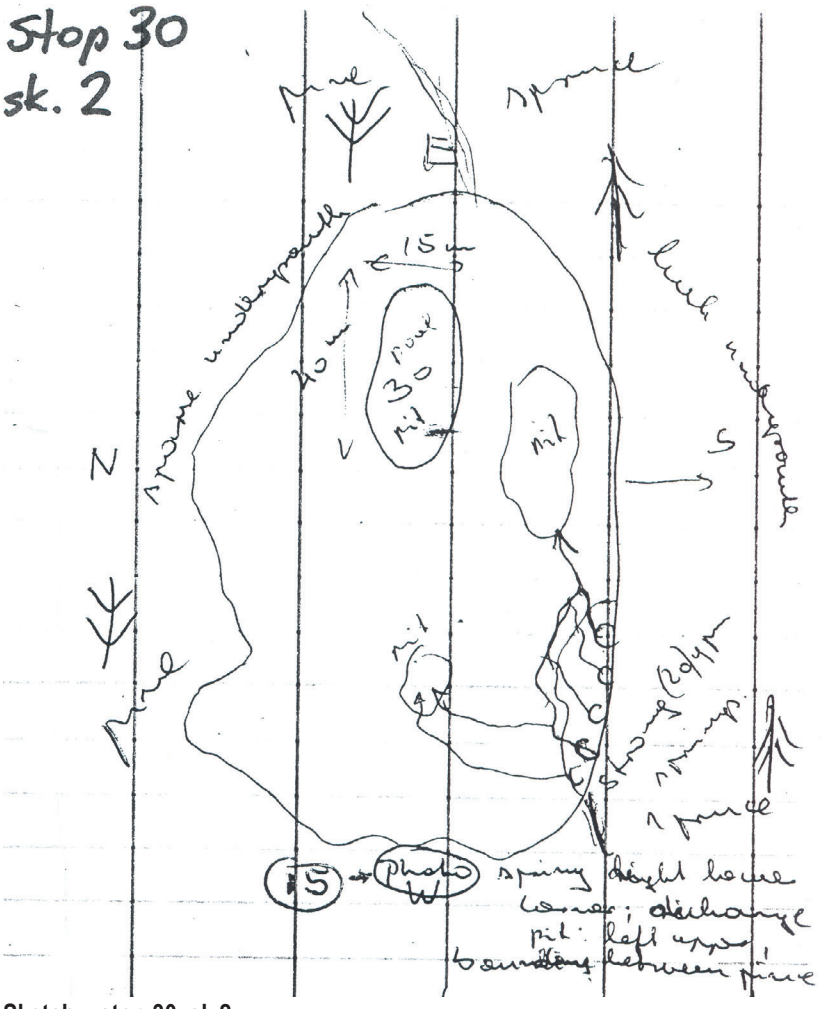
Large body of strikingly clear, bluish water in pit in well worn clean sand and gravel.
Size of pit: 40 x 15m; 5 m in depth; 4 m to water. Water surface is probably water table.

T=51 °F C=215 µmohs/m

Pit is located on edge of a spruce dominated (upslope) and pine dominated (down slope) forest.
Appearance: Pine may represent a local recharge area, generated by a terrace?!



Sketch – stop 30, sk.1



Sketch – stop 30, sk 2

Photo 15

Stop 30-15

At the west end of the total excavation strong springs occur. This may be the discharge side of the area.
Spring water
T 37 °F C=220 µmohs/m (water sample 30)

31 Roadside springs and seeps
Water discharges at several gpm:
T=47 °F C=300 µmohs/m

Water is seeping out of bank and bubbling up through small holes bringing sand grains dancing up.
Clay in ditch becomes pseudo fluid / liquid if vibrated by foot sole.
Mixed spruce and pine
Lush undergrowth.

July 19, 1968

Rained all night, rainy, very heavily overcast in the morning.

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32 North Saskatchewan River, west of Hwy. bridge

T=47 °F C=160 µmohs/m (Water sample 32)

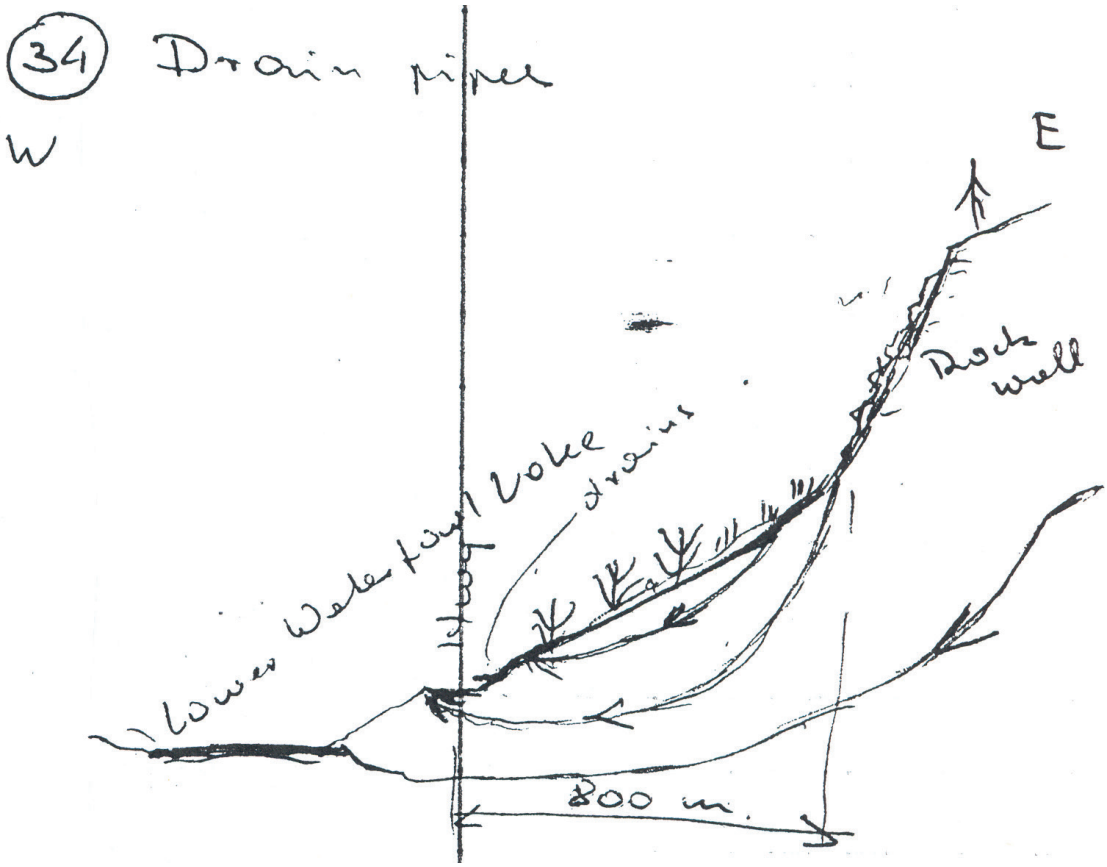
33 Drain pipes and seeps along highway 93.

Drain pipes (three) inserted into gravel road bank, 2 to 3 m in height, just S. of deeply incised tributary of Mistaya River. One pipe was observed north of the culvert bridge.
Forest vegetation is mainly spruce, with low growing firs observed. The ground vegetation consists

mainly of broad leaf plants on the E side (uphill) of the road, whereas it is a dense moss carpet, without leaf plants on the west side.
Slight slumping in banks. Under the banks in the ditch probable perennial seepage is indicated by stale appearance and algae growth.
Only one of the three drains was dripping at a rate of approx. discharge 0.02 gpm.

T=49 °F C=590 µmohs/m (Water sample 33)

34 Drain pipes



Sketch – stop 34

Drain pipes in high (8 m) gravel road bank. Steep scree slope behind it, which is flanked by steep rock wall farther east. Slumping in gravel bank.
Discharge of one pipe: 0.035 gpm

T=49°F C=410 µmohs/m (Water sample 34)
Lake water: T=50°F C=165 µmohs/m (Water sample 34 Lake)

Numerous seeps are indicated by rushes, horse tails, and other plants between **33** and **34**.

At **34** the scree slope is vegetated mainly by pine, with some spruce mixed in. Ground vegetation is sparse, few broad leaf plants: clean forest bottom.

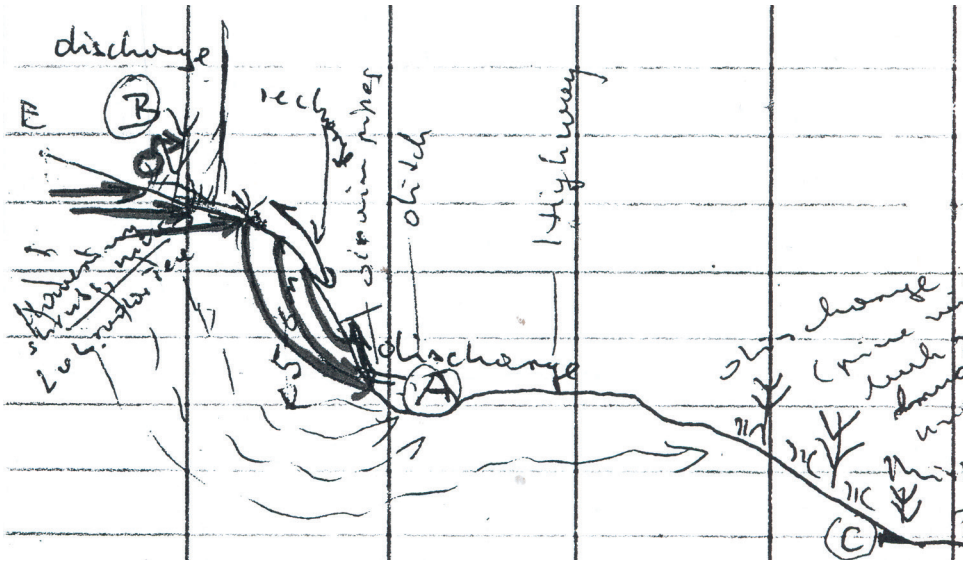
35 Drain pipes

Three or more sets of 4 to 5 pipes are inserted into 2 to 5 meters high gravel road bank.

Photo 16

Stop 35-16

Photo: green discharge area; bank edge recharge; pipe discharge



Sketch – stop 35

Total estimated discharge of 7 pipes: 12 gpm
Individual discharges range 0.01 to 6 gpm.
In addition, water is discharging through gravel face. Total length of piped section is approx. 100 yards.

Close and toward East from the edge of the bank water is discharged through seeps and springs. The water flows overland and visually disappears into the upper edge of the gravel bank without the presence of a rise opposite. The water reappears again at the drain pipes.

This is a natural scale model of mountain groundwater regions. The fact, on the one hand, that the water reappears indicates that below road level the rock is either impermeable (unlikely) or saturated, i.e., a larger system exists. The fact, on the other hand, that the water does infiltrate at the edge indicates that recharge areas may develop on discharge portions of larger systems.

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Water quality:
T=48 °F C=310 µmohs/m A (pipe water)
T=41 °F C=380 µmohs/m B
T=46 °F C=320 µmohs/m C
(Water sample 35 – steel pipe)

36 Large circular seepage

Circular, flat bottomed depression approx. 40 m in diameter is situated at foot of mountain slope. Bottom of depression is dangerously spongy but soggy only towards the centre, which is covered with short rush mat. Surrounding vegetation is pine and spruce with rich ground cover of shrubs, Labrador tea, etc. Various small channels lead to central discharge channel in a dendritic pattern from points of individual emergence. Most of these channels are lined with a veneer of mollusc shell fragments which gives it a whitish appearance.

Water: T=54 °F C=400 µmohs/m
Combined discharge =2-3 gpm

Photo 17
Photo: Seepage with mountain in background.
Seepages are apparent on both sides of the highway.
The estimated length of this flow system is similar to that at **34**.

37 Drain pipes

Approximately 20 pipes in five meter high gravel bank. Total discharge through pipes: 80 gpm (+much seepage through entire rock face)
Range of seepage: 2 to 3 gpm.

T=43 °F C=210 µmohs/m
(Water sample 37)

Photo 18

Photo: drain pipes in gravel bank discharge rate measurement.

Photo 19
Photo: hummocky, lushly vegetated road bank associated with seeps; drain pipes in background, spruce forest

Stop 37-18

38 Bow Pass Climb – West side

Photos 21-22

Photo (1): Abrupt change in ground's vegetation on both sides of mountain draw, dark (left) side facing north, light facing south.

Photo 23
Photo (2): even slope with uniform dwarf-evergreens vegetation above the tree-line looking south, Bow Lake in background.

Stop 38-20

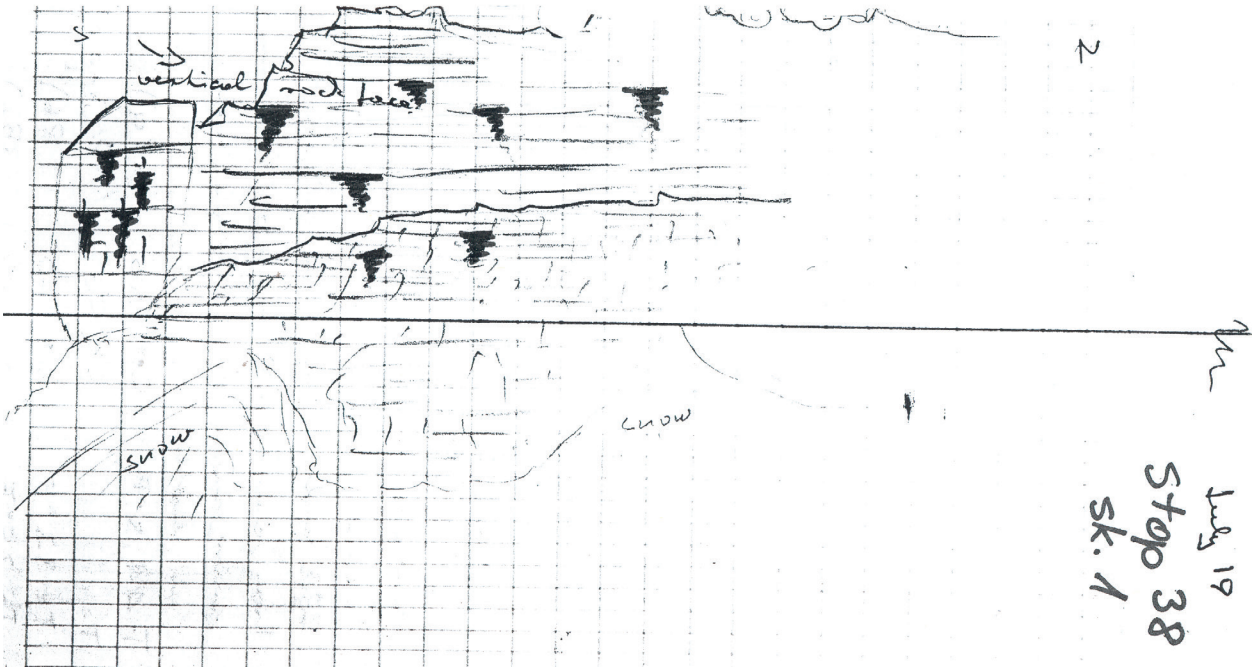
Stop 38-27

Photos 25-30

Photos (3): Series of photos – panoramic view of Bow Pass valley, looking east, starting from north to south, at Ranger's Cabin, to Bow Lake.
Skoony meanders with inflowing seepage water on bottom of valley.

Photo 31

Photo: seepage out of vertical sheer rock face through bedding planes and fractures. (left-hand side portion of diagram)



Sketch – stop 38, sk. 1

This water may infiltrate just on the top of the rock cliff from snow melt and rain; may be regarded as the "first system" in the mountains.

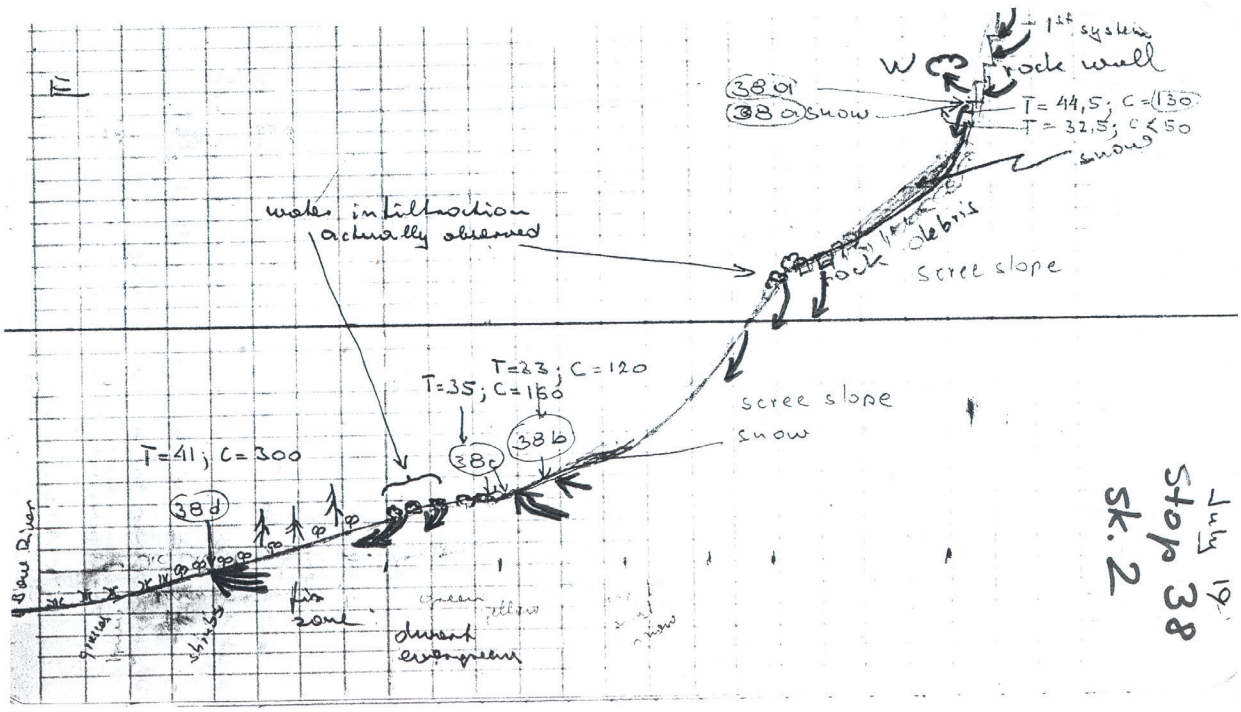
__.__
Rock wall shows white precipitates through binoculars (lichens & salts when observed from close)

__.__
The water of the "first system" may then evaporate or infiltrate again.

__.__
Compare mountain profile on one of the pictures with Bow Lake (first slope to the left of the lake) with diagram on July 18 postulates! (July 18, page 11)

__.__
(Water sample 38a)
This is water flowing over the sheer rock wall, of unknown origin. May come overland directly from the snow melt or through rocks or both.

T=44.5°F C=130 µmohs/m (**38a**)
T=°F C<50 µmohs/m (**38a snow**)
T=44.5°F C=120 µmohs/m (**38b**)
T=44.5°F C=160 µmohs/m (**38c**)



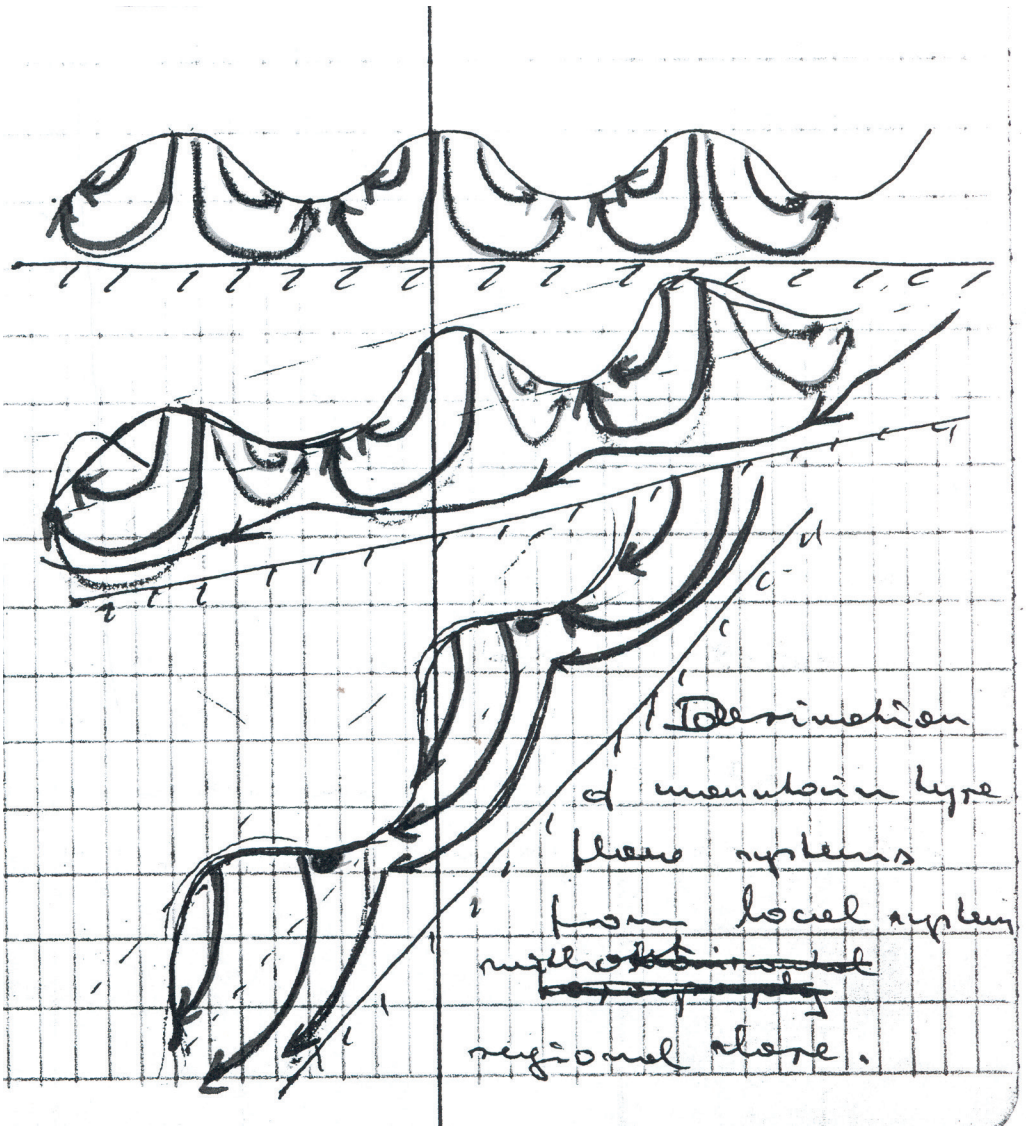
Sketch – stop 38, sk. 2

38c Circular depression in steep mountain side, with permanent looking seepage. Algae, velvety, moss, various broad leaf moisture loving flowers, dwarf evergreens.

Photos 33-34
Photo: spring
Discharge: approx. 20 gpm.
T=35°F C=160 µmohs/m

38d Seepage in circular depression out in the shrub zone but still approx 15 – 20 m above the valley floor. Mosses, "silver willow", Juncus indicate permanent discharge of water at this point.
From the upslope end of the fir zone, towards the down slope end of it the dampness of the ground perceptibly increasing, which is seen by the increasing thickness of moss cover, the increasing density of phreatophytes, and the appearance of seeps or seep-depressions.
Discharge (estimated from memory): at least 100 gpm.

T=41 °F C=300 μmohs/m



Sketch – stop 38, sk. 3

Postulate:
(further development of Post. 1 of July 18, 1968):

(1) In mountain region the local systems directed opposite to the regional slope degenerate to nil, and only a series of unidirectional local systems will exist, with alternating recharge-discharge areas. Intermediate and regional systems may underlie the local systems.

July 20, 1968

39 Drain pipes & seepages in road bank

Strong seepages associated with slumping are observed all along the highway between **38** & **39**, opposite to Bow Lake. Phreatophytic vegetation obvious. Drain pipes discharge over 50 gpm (visual estimate).
Drain pipe water (39a): T=48.5°F C=285 µmohs/m
Bow Lake water (39b): T=45.5°F C=140 µmohs/m
(Water samples 39a & 39b)

Photo 35

Stop 39-35

Photo: seepages, drain pipes, slumps along Highway 93, in road bank opposite to Bow Lake

Approx. ½ mi south of **39** three breaks in road issue water through pavement. Also farther south breaks in pavement seem to be associated with strong roadside seeps.

40 Spring discharging from under highway

Photo 36

Photo: Lush "mountain discharge vegetation", with horse tail (background), mosses, (water fall) leather leaf, alder, Labrador tea, dwarf evergreens, silver willow, etc. Creek is from highway drain/discharge seep. This location is still several 10's of meters above valley bottom.

Strong flow of water from under west side of highway, through culvert pipe. Culvert does not extend across highway, and no water is observed infiltrating into the east (upslope) side: the water must be normal groundwater discharge, collected artificially under the pavement to protect the road. The area has a very lush moss, horse tail, broad leaf and other moisture loving vegetation. Discharge is carried away by well defined channel lined with algae, and appearing permanent.

Measured discharge: 60 to 70 gpm.
T=42.5°F C=220 µmohs/m
(Water sample 40)
(Plant specimens)

41 = **13** Seeps & springs.
Very strong springs and seeps all along the highway between **40** and **41**.
Water from spring: T=45°F C=230 µmohs/m

(Photo of associated hummocky ground and slump taken at 13.)

42 Drain pipes
Long row of drain pipes in east (upslope) side of highway. Discharge of the pipes is small (in the order of 0.05 gpm) but associated slumping and appearance of phreatophytes is important. Forest is spruce & fir mixed with some pine.

T=54°F C=375 µmohs/m
(Water sample 42)

43 Drain pipes, seeps, slumps
The general conditions are similar to those at previous location. Main tree type, however is pine.
Water sample from drainpipe, issuing at 0.05 gpm.

T=59°F C=300 µmohs/m
(Water sample 43)

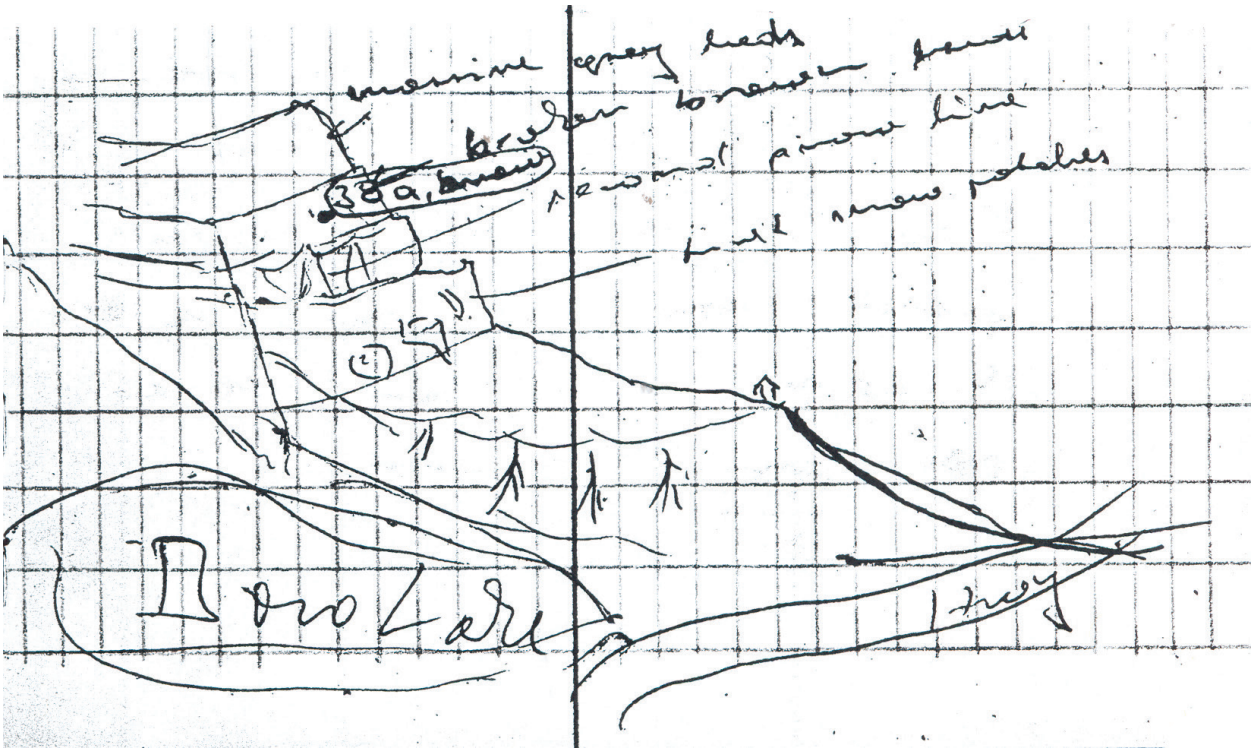
44 Seepage water collected in brook
A few tens of gallons per minute is running by the lower terminal of the ski chair lift. Phreatophytic vegetation, mosses, suggest permanent flow.

T=51°F C=380 µmohs/m
(Water sample 44)

45 Seepage water collected in brook

T=54°F C=360 µmohs/m

Photo 37
Photo: From south end of Bow Lake, to the north: cross section (profile) of mountain climbed July 19 at 38.



Sketch – stop 45

Photo 38
Photo: same as previous, from north end of Bow Lake.

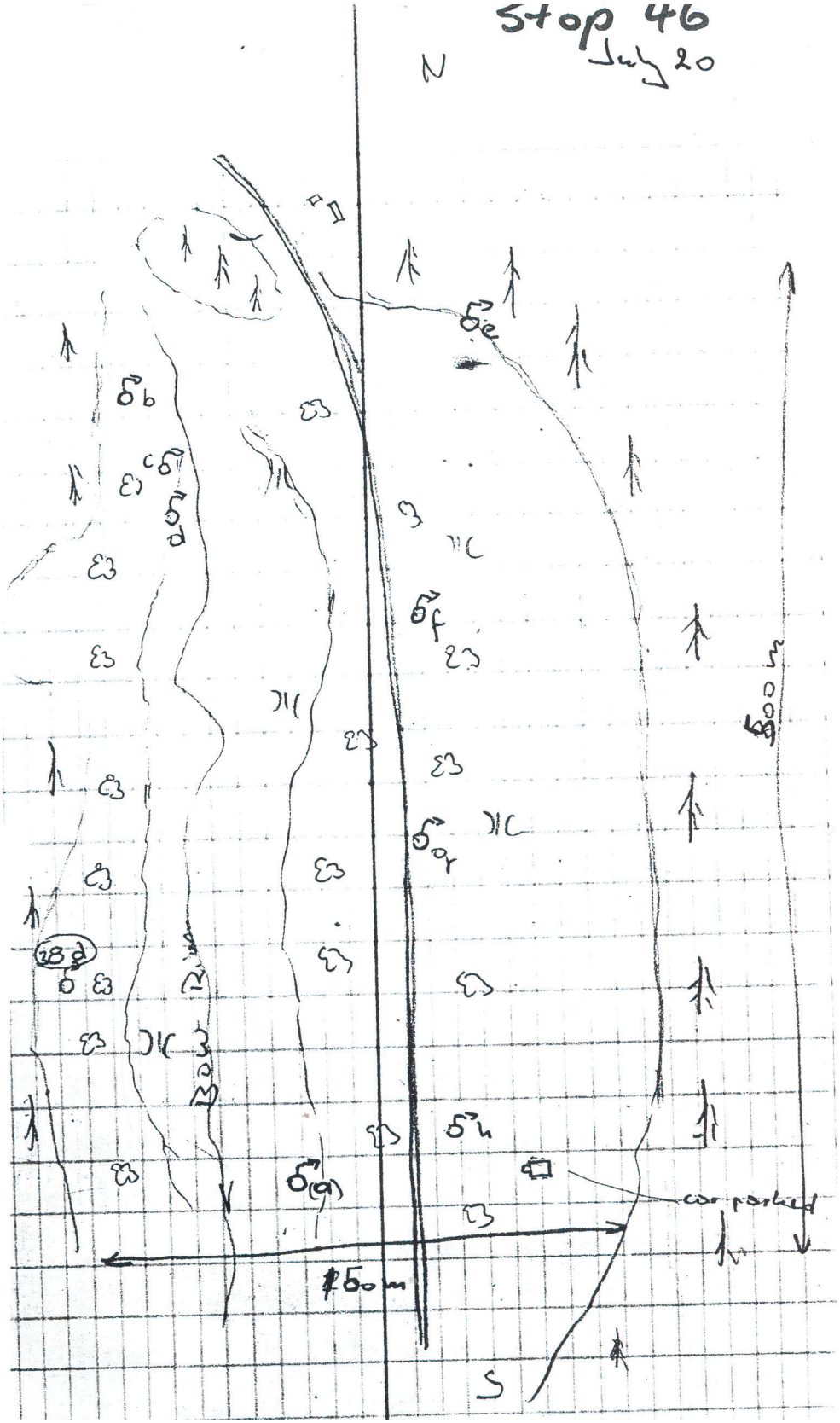
46 Bow-Pass-Walk

a) spring T=40°F C=220 µmohs/m Q=3 gpm
b) spring T=43°F C=245 µmohs/m Q=10 gpm
c) spring T=46°F C=330 µmohs/m Q=2 gpm
d) spring T=46°F C=270 µmohs/m Q=2 gpm

Photo 1
Photo: Shrub-grass boundary in Bow Pass Valley, also showing intensive discharge and associated hummocky ground.

e) bubbling spring T=40°F C=160 µmohs/m Q=?
f) spring T=50°F C=335 µmohs/m Q=0.5 gpm
g) spring T=44°F C=315 µmohs/m Q=0.1 gpm
h) spring T=42°F C=165 µmohs/m Q=various

Strong discharge points, with 5 gpm or more at base of gravel bank. Seepage spots are lined with moss, and have permanent appearance.



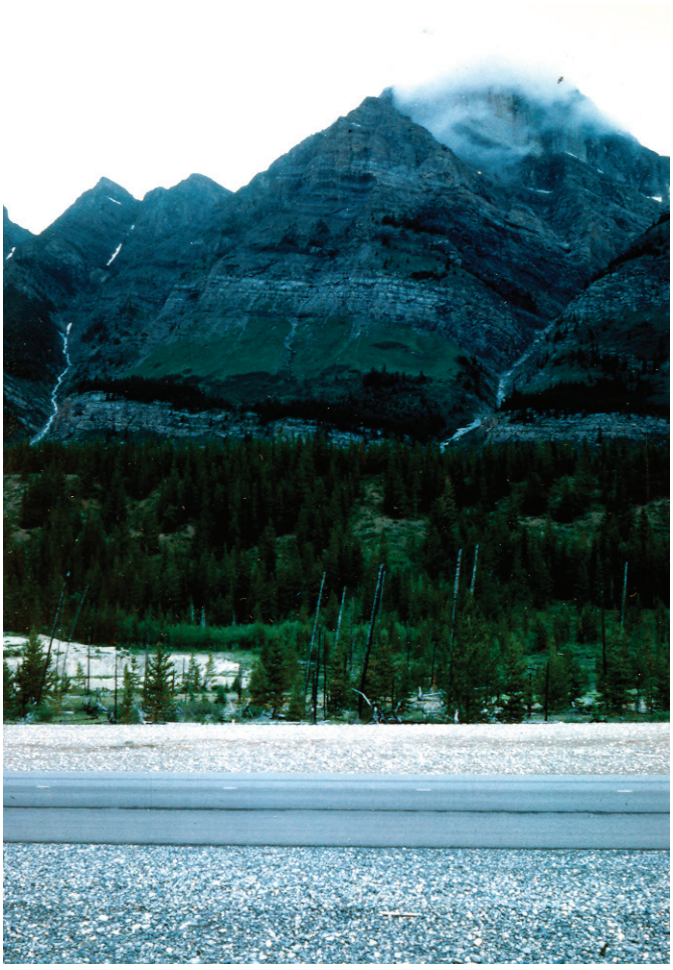
Sketch – stop 46

July 21, 1968

Lv. Sask Bungalow: 9:30 AM: 994 mi.

47

Photos 2-3



Stop 47-3

Photo: (2) Mountain to be climbed.
Trip: David Thompson Crossing Climb.
Start: approx. ½ mi. east of Hwy 93 junction.
Climb south facing slope of mountain. Mountain side and toe are noticeably drier than previous (**38**) mountain side. Rock is thin to medium to marine bedded, very dense limestone or dolomite. Scree slope is thin, bedrock outcrops at various locations. Rock is dipping north, at approx. 30°.
At various but sparse locations water is dripping out of bedding planes.

Photo 4

Photo: thin bedded limestone dripping water (sample 47a). Water sample being taken.
Mountain is dissected by major V shaped ravines, carrying large quantities of water. At stop (a) discharge is approx. 200 gpm.
Relatively high moisture content on thin bedded shale is indicated by yellow flowers.

Photo 5
Photo: Hydrogeol., dog, with N. Sask river and Hwy 93 background.
Water sample 47a spring T=53°F C=300 µmohs/m
Water sample 47a creek T=50.5 °F C=180 µmohs/m

47b Large spring

Large spring, over 20 gpm. issuing from thin bedded, fractured shaly limestone (med. grey). Approx. 30 m above (**a**) shale is broken along major fracture planes, dense pattern of drain fractures. Rock surface is brown iron oxide and / or algae coated. Above discharge points the vegetation consists of mosses, spruce and phreatophytic shrubs.

Strike: 240-260 Dip: 15° North
(Water sample 47b:) T=41°F C=225 µmohs/m

47c Spring

Photos 7-8

Stop 47c-7

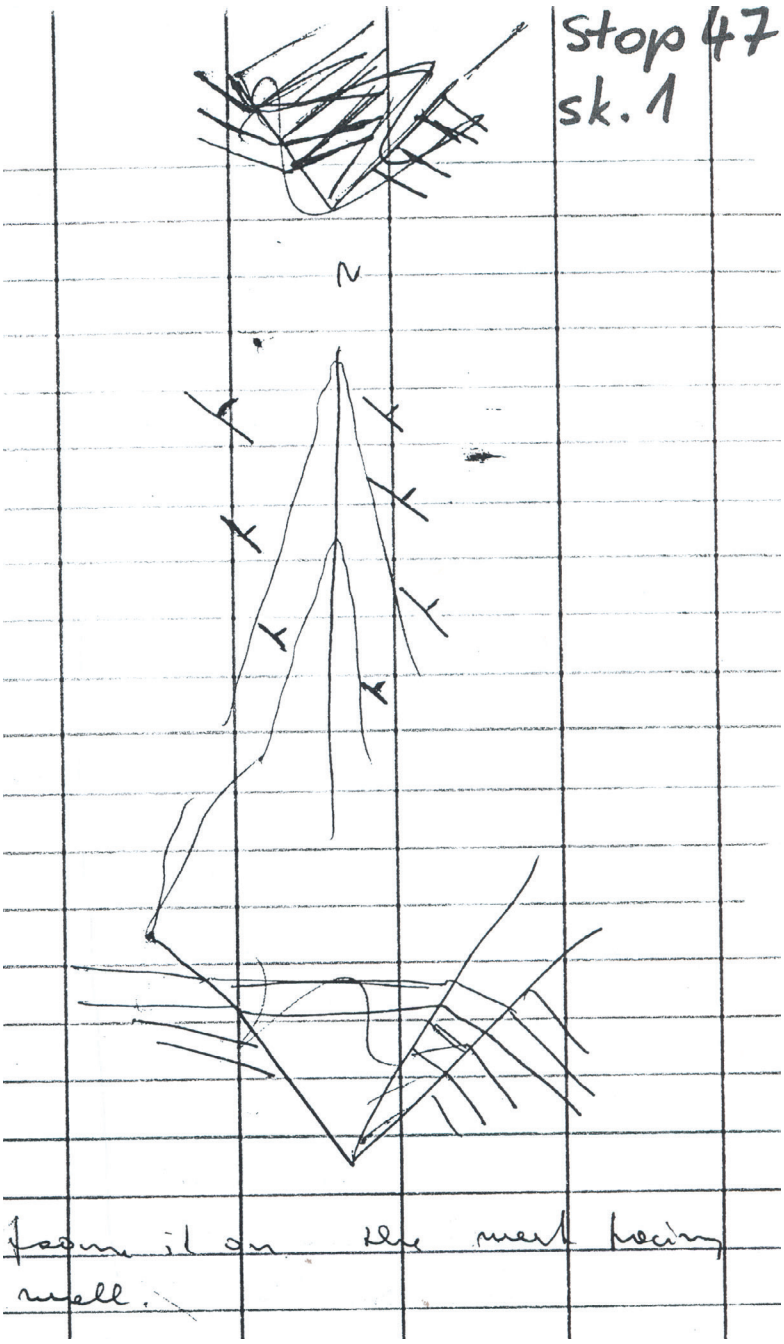
Stop 47c-8

Photo (2) [one with, the other without Richard Stein squatting]:
Water is issuing through fractures between two major fractures, and through bedding planes. Mosses, horse tail, shrubs indicate moisture. Calcite veins, iron oxide coating.

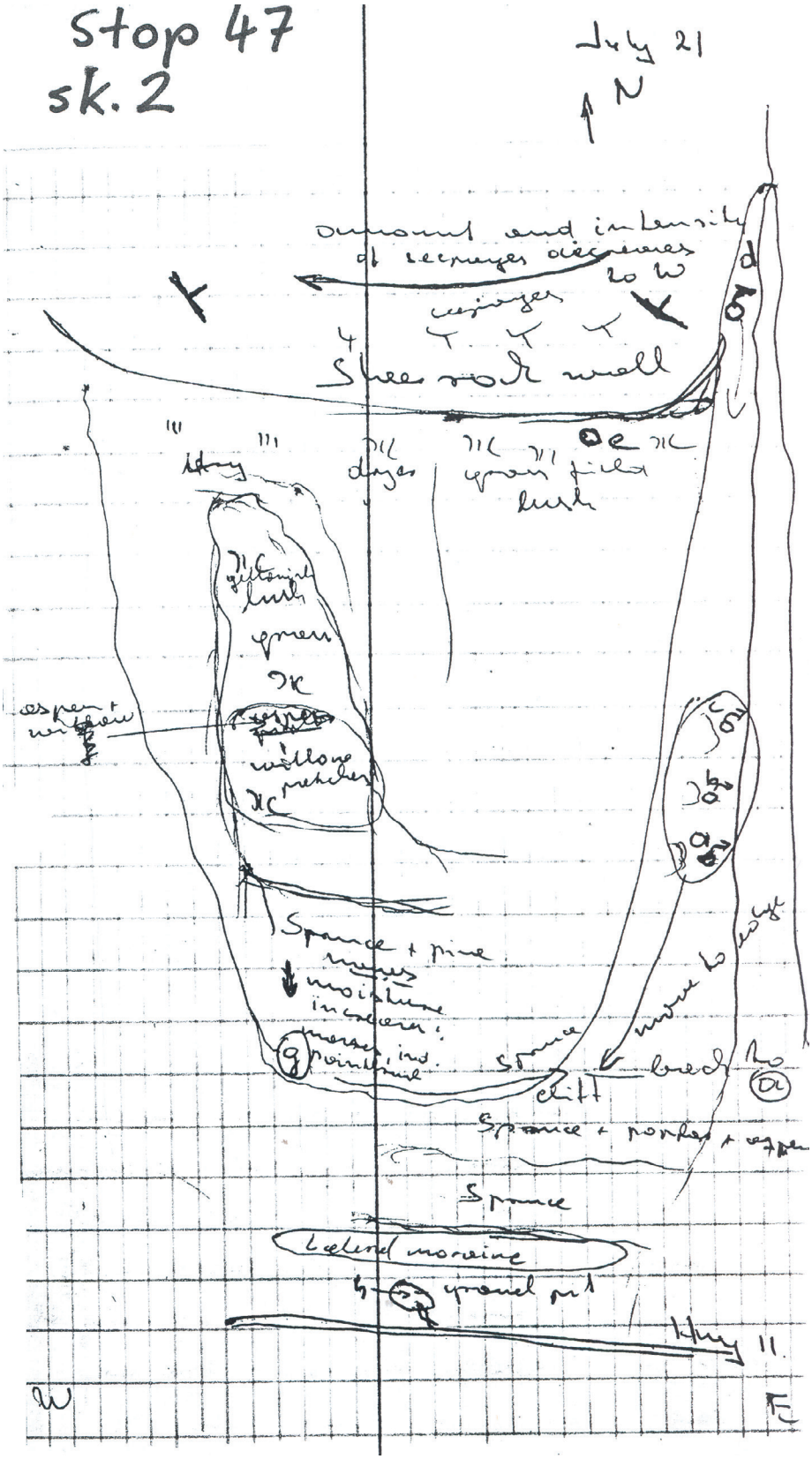
This type of spring is systematically reoccurring on the east facing wall of the ravine and is apparent, but less intense on the west facing wall.

Water (creek) T=50°F C=170 µmohs/m
Water T=46.5°F C=230 µmohs/m

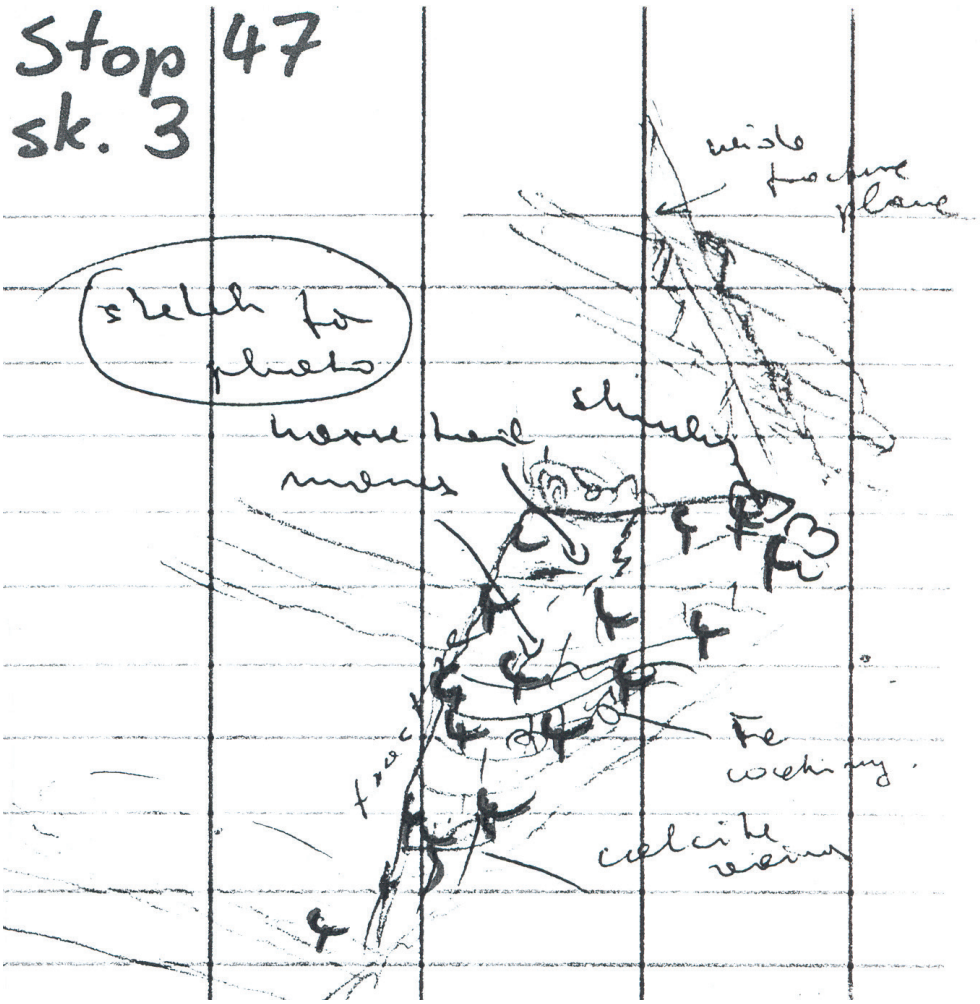
This is probably due to the fact that the beds are dipping toward the ravine on the east facing, and away from it on the west facing wall.



Sketch – stop 47, sk. 1



Sketch – stop 47, sk 2



Sketch – stop 47, sk 3

Photos 9-11
Photo: (1) Seepages on the sheer rock wall mainly along fracture planes, immediately above the vegetated belt.
(2) Taking water sample at 47d spring
(3) Water coming out of the rock at perceptible rate through invisible pores. Tiny calcite pinnacles form on rock face. Rock is dense grey limestone (dolomite). Water probably moves along the planes of thin beds, which however, are not well seen on the face.

47d Seepage at the bottom of the sheer rock wall, coming out of fractures.

(Water sample 47d seepage) T=55°F C=220 µmohs/m

Photo 13
Photo: seepage through thin fracture bedding planes.

(Water sample 47d creek) T=51°F C=163 µmohs/m

Large number of seepages out of sheer rock wall, but much of it evaporates before forming surface flow

47e

Photo 14

Stop 47e-14

Photo: Upper boundary of grassy slope; grass is very lush despite thin, almost nonexistent scree cover. Wet spot = groundwater discharge in one of various discharge points (seen on one of previous pictures – shiny fracture plates) starting slightly above grass fields. Point is: without major slope change or lithological or any other, groundwater discharge starts high on a sheer rock wall and will cause vegetation to start. This spot is approx. 500 ft. above first seepages.

Photos 15-17

Photos from 47e: (1) to SE; (2) to S; (3) to SW;
(2) Sask Bridge of Hwy 93 with Mistaya River; (3) N. Sask valley upstream from bridge.

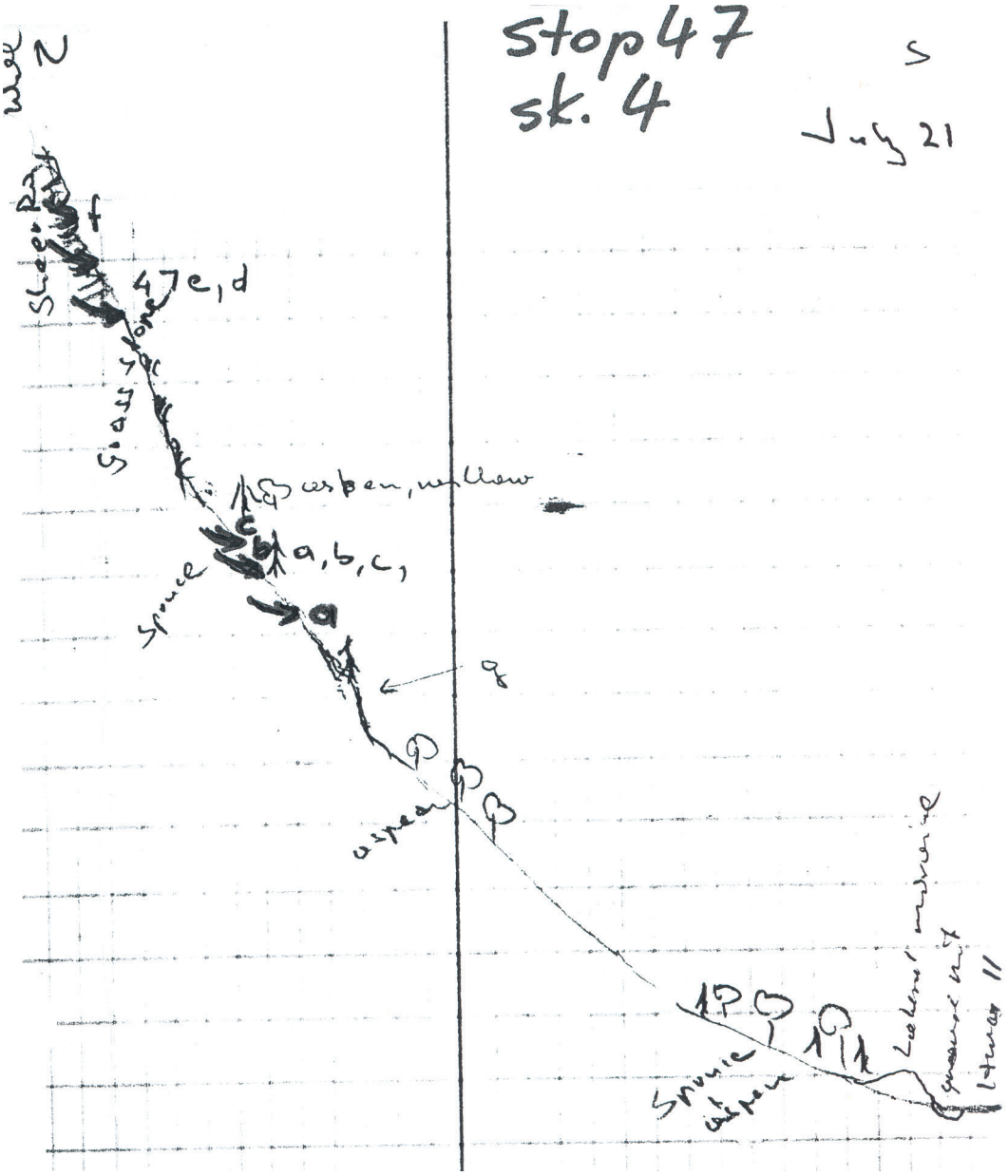
Dip: 30°NE; Strike: 295

47f seepage:

(Water sample 47f) T=65°F C=175 µmohs/m

Intensity and number of seeps decreasing to the west. This must be due to the fact that the beds dip to the NE.

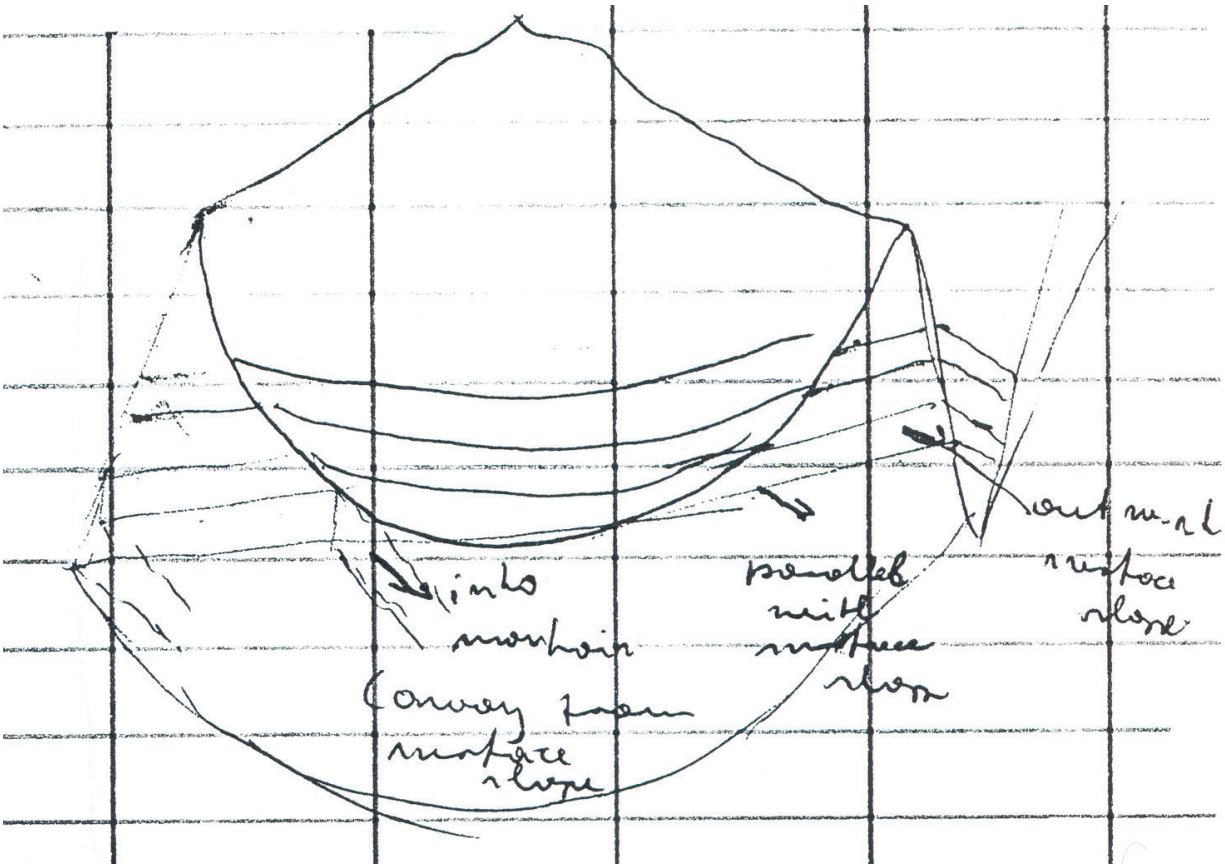
Photo 18
Photo: to the East: contact between grass slope and sheer rock wall from west corner of mountain.



Sketch – stop 47, sk 4

47g Edge of cliff: coming down slope moisture increases between aspen + willow patch and g. Mosses and lush broad leaf plants, alder, spruce fir & pine.

Ground moisture, as indicated by the vegetation is definitely increasing from (g) to (a). This must be due to the change of the relative positions of dip and top surface.

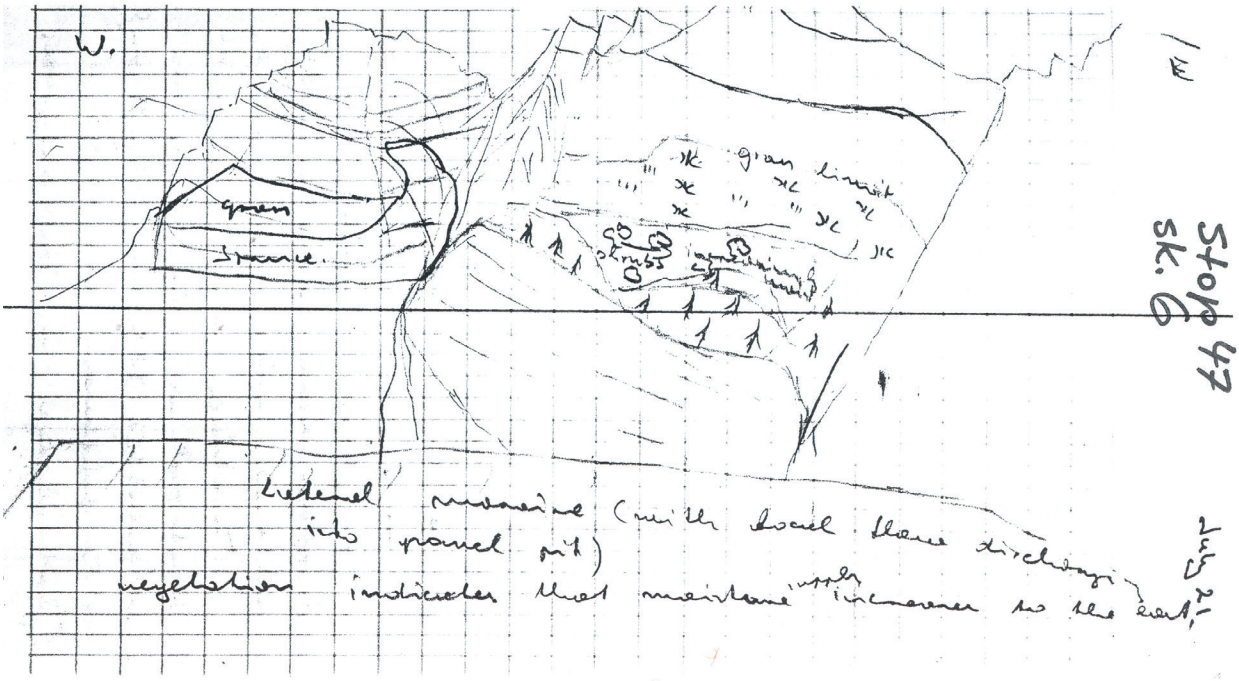


Sketch – stop 47, sk. 5

47h gravel pit with strong springs

The recharge area of this system must be the lateral moraine only 100 yards away.

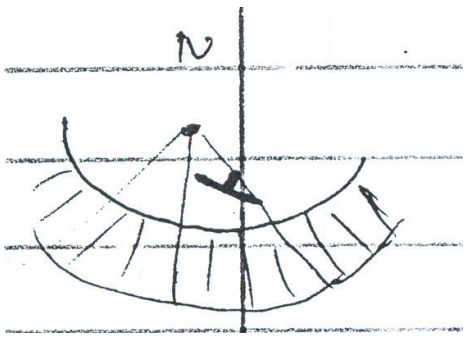
(Water sample 46h gravel pit) T=48°F C=190 μmohs/m



Sketch – stop 47, sk. 6

Trip **47** has shown the importance of bedding (the attitude of beds), on the distribution of the groundwater flow.

The rock is dense, fractured limestone or dolomite dipping NNE. The mountain faces SW, S, and SE directions:



Sketch – stop 47, sk. 7

On the southwest facing walls seepage is less abundant than on the S and SW ones. This increase in seepage is reflected very definitely by the: (1) vegetation, and (2) the number and intensity of seepages and springs.

Conductivity of seepage waters decreases systematically with altitude.

Fractures play a very important role in the bulk permeability. It is mainly through the fractures that water discharges on the SW slopes also.

The general appearance of the valley and mountain side is moderately moist. This may be due to the following factors:

(1) very thin or nonexistent scree slope, preventing large quantities of infiltration;

(2) dense rock type, with moderate fracturing, rendering the bulk permeability low;

(3) bedding dipping away from the surface.

It is interesting to note, that the vegetation pattern must be controlled entirely by groundwater distribution, since the uniformity of slopes does not allow a nonuniform distribution of surface water; the nonsymmetry of the bedding with reference to the slopes, however, results in a nonuniform groundwater distribution. The relatively low infiltration must, then, result in high surface runoff. That this is true is evidenced by the numerous, dry rock-filled gullies, which were absent on Crepe Mountain, or at Larch Valley traverse.
The low conductivity of the gravel pit water indicates the shortness, and high intensity of flow in the moraine system.
Apart from the springs and seepages through the "sheer rock wall" no other points of concentrated discharge have been observed. Yet the vegetation shows a good supply of water which must come out of groundwater since surface water could not stand on these steep slopes (was dangerous on the grass slopes).
Thus: all discharge is used up by the vegetation and evaporation. The latter is evidenced by the numerous seeps on the sheer rock walls which do not form saturated flow (photographs).

48 =1 Spring

(Water sample 48) T=44°F C=335 µmohs/m

Creek water 50 m uphill from spring, discharging several hundreds gpm.

T=41°F C=335 µmohs/m

Thursday, July 25, 1968

Lv. Rocky Mt. House at 1:30 PM; 14007.0 mi.

Friday, July 26, 1968

50 Flowing seismic shothole

LSD 7-22-34-9W5M
Located on valley side, several tens of meter above deepest point. Vegetation is pine, spruce, lush sedge, alder, but no real muskeg.

Brazeau Form.
(Water sample (2 bottles) 50)

T approx. 42°F C=300? µmohs/m

Photo 21

Stop 50-21

Photo: flowing shothole, with valley in background.

51 Roadside seep
LSD 1-10-34-9W5
Perennial seepage along road. Well frequented by game. Iron staining; algae; lush, mainly sedge vegetation. Poplar, alder, pine, willow.

T=45.5°F C=500 µmohs/m

52 Spring
LSD 11-9-34-9W5
5-6 gpm. Well developed channel, white spruce, alder; balsam fir, goose berry, willow, mosses
T=40°F C=120 µmohs/m (could be diluted by rain water)

53 River Floodplain: of Red Deer River
Large, flat, extended plain with abruptly rising, well defined flanks. Plain seems to be rather moist, as indicated by a rich but not abundantly luxuriant sedge & juncus association. Southwest facing flanks are grass covered & uniform in appearance with patchy aspen groves. Edge of flood plain is lined with willow; few seepages noticed.

54 Spring
In the flank of the valley. Permanent looking (appearing), with moss lined channel, flow of water, discharging about 10 m above the previously described flat valley bottom. At this point, valley bottom is covered with phreatophytic grasses, willow, spruce, and exhibits permanently wet characteristics: mosses, soggy bottom; shallow, unvegetated mucky ponds of water, etc. This is probably the natural

aspect of the grassy plain of **53**, which, now seems, has been cleared of the shrubs of ranching purposes.
Measured discharge: 8 gpm

(Water samples (2) 54) T=42°F C=560 µmohs/m

55 Spring

At Eagle Creek crossing. Large (30 m radius) semi-circular depression with numerous points of discharge, supplying water to moss lined discharge channels of permanent nature. Spruce, willow, alder, and other mat-forming broad leaves, and shrubs.
Discharge points lined with stones, probably part of natural thin scree.

(Water sample 55) T=43°F C=385 µmohs/m Q=5 gpm

Bottom of depression strongly sloping; outside of discharge points it is damp but firm (heavy rains during last days).

Photo 22
Photo: spring site with: water, mosses, characteristic willow shrub, spruce.

56 at Eagle Lake

a) Springs and seepages at west tip of lake. Water is discharging slightly (few feet) above lake level from under heavy moss mat; almost muskeg type. Previous year same seeps were observed by Richard Stein. Combined discharge over 25 gpm (est'd).
(Water sample 56a)
T=55°F C=360 µmohs/m
b)=Lake
(Water sample lake)
T=59°F! C=305 µmohs/m

Binocular observation:
The mountain north of the lake is of south-west dipping limestone beds. Large cave-like holes are observed in several bedding planes. Some of these caves seem to discharge water, but the total amount seems to be quite small.

Saturday, July 27, 1968

Marble Mt. traverse

57 Seepage

Active flow out of small local rise, on east side of Marble Mt. frontal valley. Discharge channel is not permanently wet looking although is a permanent drain.
Local hill consists of outcropping strongly fractured Brazeau Formation (fine grained dense, sand & pepper sandstone). Flow system is 30-40 m long, intensive but probably non permanent, being derived from, and immediately after major rain falls and snow –melts intermittent, highly variable system, made possible by high permeability due to fracturing and pronounced topography.

(Water sample 57, Brazeau water) T=61°F C=60 µmohs/m

58 Damp hillside

Gently (10-15°) but evenly sloping, south exposed hillside. Across a distance of over a hundred meters phenomena indicating moisture surplus are observed. Vegetation: sparse, low density spruce, mixed with some pine & aspen; willow. Most striking is thick, damp moss mat even on areas fully exposed to the S, SE & SW sun. This must indicate continuous contribution of groundwater to this surface.
After above remarks +/- 2 ft deep hole was dug through moss layer (approx. 15 cm). When rock was struck water started to upwell into hole with apparent force.

Photos 23-24

Photo: (1) Mossy, south exposed hillside, with moss cover & other vegetation indicating hidden discharge (View to east) (2 photos)

Photo 25

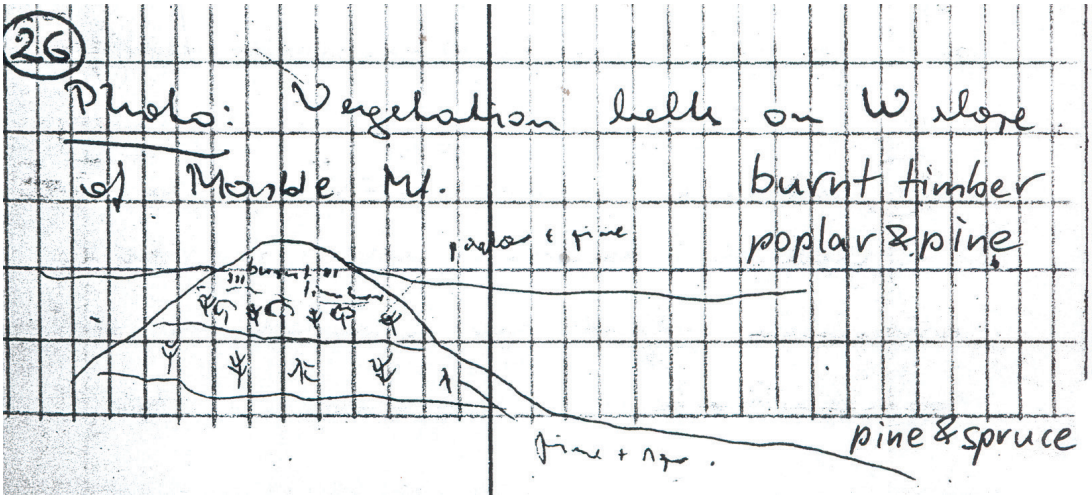
Stop 58-25

Photo: (2) Hole with upwelling water from under moss mat. (This is groundwater discharge, supplying the lush vegetation.)
Some seeps collecting into channelled water was found within an area of approx. 50 x 20 m.

Water in hole: T=47.5°F C=90 µmohs/m
Water in channel: T=54°F C=100 µmohs/m
(Water sample 58)
Judging by the C values, water must be derived from the recent heavy rains, and this system be of an intermittent nature.

Photo 26

Photo: Vegetation belts on W slope of Marble Mt.



Sketch – stop 58

59 Top of Marble Mt. at cutline crossing (Altimeter 6000 ft)

Dark grey fossiliferous, porous limestone. Rock is outcropping on top, soil cover is very thin. Pine with little underbrush. Broad leaf carpet vegetation, Indian paint brush; alder and a few more shrubs, present but not exceedingly luxuriant. In summary: Moist but no surplus of water.

Photos 27-28

Stop 59-27

Photos: (2) Typical Foothills topography, taken from Marble Mt. to SSW.
Photo 29

Stop 59-29

Photo: (3) View from Marble Mt. to ENE: NS road is on ridge, which is associated with light (drier) vegetation. Vegetation change is associated with distant hill (disappearing point of cutline). Seepage of **57** is associated with size of NS (Forestry Trunk road).

60 Mountain side (Altitude 5500 ft)

General appearance is increasing moistness, but no indication of concentrated discharge along cutline is observed, possibly due to the high density (camouflaging effect) of alder and other shrubs.

5400 ft: pebble conglomerate in debris observed.

61 Seepage (Elevation 4927 ft)

Water standing on level surface is observed over an area of approx. 20 x 2 m on the cutline. Fresh horse tail and lush grass start to grow on this portion of the graded cutline. On both sides of the cutline vegetation is very lush, with strongly developed tall (over 4 m) alders, willow & pine and spruce. Water is not flowing and no impounded water was found in the brush on the sides of the cutline. The actual presence of water and the lushness of the vegetation exceeding that at higher altitudes along the cutline indicate an excess moisture at this location and possibly the start of observable discharge features. Iron staining, green algae, moose and deer tracks indicate permanently damp conditions. Similarly flat depressions did not contain open water higher up.

Photo 31

Stop 61-31

Photo: showing contrast between seepage area and other portions of cutline. Surface does slope to the left, thus water is not impounded in surface bowl.
There is a suggestion that this moist belt is coincident with the fault at the contact between Blairmore (ss, sh, congl) and Blackstone (sh, ss) Formations.

62 Seepage (Alt. 4800 ft)
The feature is similar to that at **61**, but with more water.

General remarks – summary of descent from Marble Mt. to Forestry Trunk Road:
Dampness of the mountain side increases unnoticeably from top towards valley. Points of concentrated discharge (springs, seepages) have not been found generally, although observation was made difficult by dense tree, shrub, and grass cover. Definite seepages, but with insufficient amounts of water for sampling have been noticed at **61** and **62**. These two lines of discharge seem to be, most probably, associated with two faults as mapped by Beach (1941).
Discharge, thus, seems to be uniform and moderate over the whole slope, and even precipitation is able to support a relatively rich vegetation. Faults are zones of relatively high permeability promoting discharge.

Photos 32-33

Stop 62-33

Photos (2): E. side of Marble Mountain, taken from the road showing fault associated seepages at kinks/knicks of the slope.

63 Seepage

Wide stretch of cutline is permanently moist (75 m). Associated are: water holes, moss carpet, knee high grasses, exceptionally well developed aspen grove (aspen grown to tree size), dead trees; a generally and definitely moist region, with poorly defined, mostly moss covered drainage channels, now carrying water, probably from last days' heavy rains. This is a discharge area, but with features not seen before: again the diffuse type of discharge seems to be recurring.
(Water sample 63 (probably diluted))
T=49°F C=150 µmohs/m

64 Flat large valley bottom

Thick bog moss, but no open water. Black spruce and open fields, with thick moss mat, dwarf alder. Pine surrounding.

65 Flat valley bottom

Very thick moss carpet, with other phreatophytic vegetation. Depression is linear and not closed: yet surface water is apparent, indicating some retaining factor: it is, probably discharging groundwater, which is evidenced by banded moist steep slopes, (spot where car got stuck) what even heavy rain would not cause.

66 – 66a Relatively dry area

Relatively dry area dominantly lodgepole pine in stands of low to medium density. Sparse ground cover vegetation. Recharge area?

67 Headwaters of Raven River

{Dr. Tóth's notes in margin: "as observed at rancher's spring on 'Western Springs Workshop' July 29 2009"}

Extensive, flat, hummocky plain with lush grass vegetation and willow brushes. Ground is firm and patterned, without noticeable water on it. ("Patterned" means: hummocks are körülvéve (surrounded) by wide -6" to 1 ft. –polygonal cracks, which are vegetated.)

In one instance, however, a triangular shaped "collapse" hole, was found 5 m each side, 1 m in depth containing water which is discharging from it, underground at a rate over 5 gpm. The whole soil section (1 m) is peat moss.

River water (Raven River)
T=44.5 °F C=345 µmohs/m

(Water sample 67: collapse hole)
T=40 °F C=435 µmohs/m

68 Drive
Between **67** and **68**, driving on nearly horizontal ridge between Stony and Raven Rivers: relatively dry, yet good growth of vegetation. Pine, without ground carpet. True pine "forest"; mature trees.

69 Well water
Clearwater Ranger Station
(Water sample (2) 69)
T=47.5 °F C=540 µmohs/m

Fall 1967, spring 1968 dry, springs, consequently many of the streams have gone dry.

70 Sulphur Spring
Discharging from under road fill onto flat. Yellow deposit, yellow algae, sulphur smell.
T=44 °F C=1250 µmohs/m Q>100 gpm

71 Spring
Major flow on S side of Hwy opposite to limestone outcrop. Reported by ranger to be perennial.
T=42 °F C=380 µmohs/m Q=several 100 gpm
Very lush horse tail, mature black spruce vegetation.
Outcrop is marine bedded, well jointed limestone.

72 Water well (13 mi. west of Ricinus Store)
At Boundary Service Station.
Well depth 18 ft; Water level 15 ft.
Pumped at over 100 gpm without drawdown.
(Water sample (2) 72)
T=50 °F C=510 µmohs/m
(likely colder in ground)

Sunday, July 28, 1968

73 Water well
Depth 80 ft
T=50.5 °F C=830 µmohs/m Q=5 gpm
(can take out 90 gall., has to wait 20 minutes, can repeat)
Farmer does not know of springs, although lived 30 years in area. Muskeg plentiful.

74 Farmer's report: spring at **74a** & **74b**.
In his own yard four wells, of approx. 80 ft. in depth, 3 ft. to bedrock. Aquifer is sandstone, plenty of water, could not pump them dry with the ordinary pressure system.

74a Spring
Water discharges at the head of well developed coulee (V shaped, 5 m deep, 40 m at top). Coulee is tributary to Clearwater River.
Vegetation is mixed poplar, aspen, white spruce, pine, willows and other shrubs. Trees are vey well developed.
Water is discharging at approx. 1 gpm or less, and disappears 50 m from point of emergence (infiltration and evaporation). Nevertheless, (despite the small discharge) it flows year around, building an icefield in the winter. Ravine extends more than 100 m upstream beyond point of emergence.

T=49 °F C=600 µmohs/m Q<1 gpm
(Water sample 74a)

74b Spring
Water discharging from strongly jointed, med. coarse, pepper & salt soft porous sandstone. Major coulee is developed. Associated vegetation is lush grasses, horse tails, and broad leaves, shrubs & trees.
T=52°F C=600 µmohs/m Q~5 gpm
(Water sample 74b)
Some iron staining, and green clumpy algae. Bedrock is exposed in bottom and sides of coulee (5m deep). Spring runs year round, according to farmer.

75 Spring (perennial)
Strong flow of water emerges out of side hill through well defined outlet, on south side of circular depression. Very lush vegetation despite the area being used for cow grazing. Exceptionally well developed mature aspen forest.

T=41.5°F C=440 µmohs/m Q~25 gpm measured

Discharging water runs off in well defined channel. Discharge out of bedrock. Surrounding of channel soft, soaked; area is generally discharge of character (bogs, phreatophytes)
The spring water runs into a muskeg on the north side of the road, with black spruce and tamarack, sphagnum moss.

76 Water well
Depth: 80 ft
Water level: 25 ft
Sandstone & shale: sufficient supply

T=44°F C=640 µmohs/m Q=?

77 Water well
Depth: 110 ft
Water from 110 ft out of shale
Water level: 60 to 70 ft
Quicksand 30 ft and below to 110 ft.
T=42°F C=600 µmohs/m

Send report to *(name and address removed for privacy)* Caroline

78 Spring
Water
T=42°F C=630 µmohs/m Q~40 gpm measured

Strong flow out of drainage gallery constructed under Hwy, of steep embankment of Raven River. Flow is concentrated in well developed permanent channel and discharges into river. Floodplain is wide, lush vegetation, boggy with spruce, willow, etc.
Photo 35
Photograph: spring outlet from under highway with embankment in background.
This arrangement is a water supply and hwy draining design in one!

79 Raven River fish Hatchery Springs
Large discharge of water from a multitude of issuing points. These points are lined up at the foot of a long embankment. The area is a typical discharge area with well developed black spruce, horse tail and rich moss cover. Large blocks of travertine along discharge channels.
(Water sample 79)
T=41.5°F C=510 µmohs/m

Photo 37 Right

80 Water well
Depth: 104 ft.
Water comes in 60 and 98 ft.
Gravel from 8 to 25 ft.
From 25: blue mud
Q>5 gpm
No sloughs, the rain seems to be absorbed.
(Water sample 80)

T=48°F C=500 µmohs/m Q>5 gpm

Send report: Mr. (*name removed for privacy*), Caroline

Stop 79-37

81 Water well
Well depth: 81 ft.
Water from sandstone; Water level ~ 60 ft.
Good well; thin clay and then sand rock. Water seems to infiltrate readily, no sloughs.
(Water sample 81)

T=45°F C=500 μmohs/m Q>5 gpm

Send report: Mr.(*name and address removed for privacy)*, Caroline.
General Remarks of the Day

The entire area is characterized by lush, rich, densely growing vegetation, reflecting a comparatively humid climate. However, very marked differences are consistently noticed between the plant associations of high lands and low lands.
The hill tops and higher portions of slopes have aspen, poplar, pine associations with rich but not typically phreatophytic vegetation. This association grades into spruce and pine, and farther down into black spruce, tamarack, sphagnum moss, horse tail, and other characteristically moisture loving plants. The lower portions are occupied by muskeg or less wet but still very lush hummocky, and soggy conditions.
In summary: there is a definite difference and a gradual transition between the degree of moistness on high lands and low lands, which difference is not attributable to water running over the land surface, and collection in depressions.
The amount of TDS seems to be low, conductivity values varying between 440 and 830 μmohs/m . Water supplies of local farmers are copious, and large springs exist in the area.
From outcrops and geological reports it is known that the bedrock is jointed, permeable Paskapoo sandstone. In this hydrogeologic environment the flow systems are broad (few miles in length), intensive, and have a low variability, at least compared to the Foothills regions.
The rocks are characterized by (relatively) high permeability, low soluble mineral content, and Ca, Mg, HCO3 type. Consequently, the waters, having a low residence time in these rocks are of low concentration, springs are stable.
High infiltration rates, due to intensive groundwater flow, must account for the relatively dry appearance of the high lands (no sloughs). (Evaporation is low.)
Summary: Differences between groundwater recharge and discharge areas are reflected by the vegetation. Groundwater flow expires in systems associated with the local, rolling topography. Accentuated relief, high permeability, and relatively high precipitation bring about broad active systems discharging high quantities of groundwater of low mineral concentration. Due to the broadness of the flow system (large recharge areas) flow has a low variability (even small springs **74 a,b**) run year round.
The whole day was exceptionally hot, sunny.

Monday, July 29, 1968.

82 Typical "Frontal Plains" flow sequence:
South of the Clearwater River Bridge well defined, broad valley, with rounded flanks. Sequence is well demonstrated by vegetation, going from high land to low: hay and arable; poplar, aspen; poplar, aspen, white spruce; white spruce, black spruce; black spruce, tamarack, willow.

83 Valley vegetation cross section
(a) Cow Creek floodplain: willow, black & white spruce, very tall sedges, tamarack; pine on sandy hill tops;
(b) willow, aspen, pasture, summer fallow
(c) approximately uniform mixture of aspen & pine; pasture, with hummock (mole hills); few white spruce

84 Water well
Well (1): Dug
Depth: 28 ft.; Water level: 27.5 ft.
Q>30 gpm; water from gravel
Well (2): Drilled
Depth: 47 ft; Water level: 18 ft.
Drilled through sand, completed in gravel.

T=46°F C=480 µmohs/m
(Water sample **84**)

Mr. (*name removed for privacy*) reports various springs in the general area. Several are large, some "near the top of hills", and many seepages. There is one sulphur spring with (plotted on map at Fall Creek) the "greatest amount of sulphur among all springs between Alaska and Texas", as one visitor put it. It smells like sulphur.
"Most of the springs seem to occur on the north side of the mountains' the ones that do occur on the south sides are all year around springs."
Send report: (*name and address removed for privacy*), Rocky Mountain House.

85 Sulphur Spring
Water flows out of the base of grass and tree covered slope at an almost vertically standing limestone bed. The base of the outcrop is fractured. From the geological map (Tay River, J.F. Henderson, 1943) it seems to be a member of the Wapiabi Formation, with overturned folds. Fold axes and fault planes have a NW strike, i.e. perpendicular to the steep hill slopes, which combination possibly provides good drainage ways to the water.
In the discharge channels and the pool under the rock outcrop yellow incrustations, yellow stained algae, and a slight sulphur odor attract attention.
(Water sample **85**)

T=43.5°F C=1090 µmohs/m Q~3gpm (visual)

86 Flowing well at Crimson Lake
Water level rises over ½ ft. above ground. Pine, spruce, willow, poplar, Labrador tea.

T=41°F C=470 µmohs/m

(Water sample 86)
Lake water: T=65°F C=220 µmohs/m

Tuesday, July 30, 1968

87 Corral spring, Baseline Tower. (400 ft below top of mountain)
Large spring on east side of mountain with new tower. Slope is very steep (30 to 40° measured), even. One major point of emergence (10-15 gpm) and one minor 2-3 gpm have been located. More may be present but the exceptionally luxuriant lush hip high broad leaf flowering vegetation makes observation and detection difficult.

Large spring: T=39°F C<50 µmohs/m Q~10-15 gpm
Small spring: T=44°F C=125 µmohs/m Q~2-3 gpm

The area is conspicuous by the lush vegetation, spruce growth.
Immediately surrounding the area is pine forest, with little ground vegetation, except locally. The very abrupt change in vegetation on a very steep slope with the associated springs definitely proves this area to be a discharge area; the increase in moisture content could not be ascribed to a change in precipitation.
The area covers approx. 200 x 500 m of the slope (very rough estimate, check on areal photo).
This spring was used as water supply for pack horses and old corrals are still standing nearby.
The large area of phreatophytic vegetation is indicative of/exemplifies the typical "foothill type" "intensive diffuse" type of discharge.
Photos 1-3

Stop 87

Photos: (1) General view of lush spring – diffuse discharge site
(2) General view with spruce, growing only around the spring in this area.
(3) Spring, dog, lush growth
Approximately 15 to 20 m uphill the first point of emergence was located in thick moss carpet with rich phreatophytic and spruce & fir growth. It is at the knick point of a 8 to 10 high embankment.
(Water sample **87**)

T=39.5°F C=190 Q~2 gpm (visual)

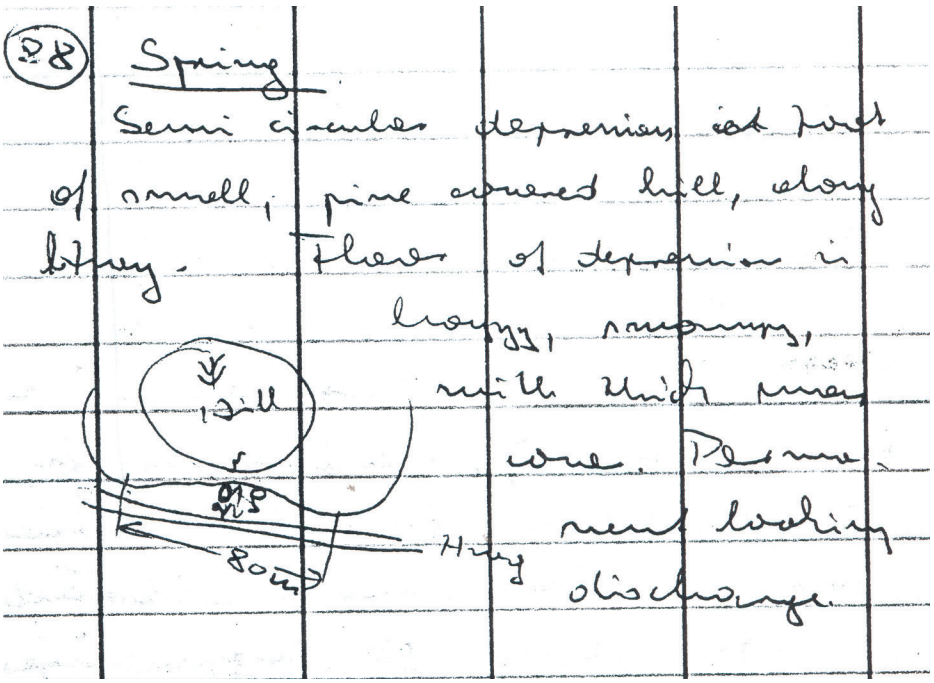
The decreasing C values downhill are probably due to an increasing amount of rainwater admixture from last night's and days' heavy rains.

Photo 4
Photo: (1) One of the discharge points with embankment, spruce in background, characteristic moss mat, few pines showing in back, high, drier area. This is at the upper edge of the spring area.
Photos 5-6
Photos (2): View from new Baseline tower to due east; contact between the Foothills and the Frontal Plains, with the first row of hills and Swan Lake. Picture shows contrast of relief between the two topographic environments.
Photo 7
Photo: (3) to W: contrast between Foothills – Mountains (Ram Range in background)

Summary of Baseline Tower trip:
Trip was taken from the west, on the west slopes.
The approx. 1500 ft high mountain side does not appear to be excessively moist. It is uniformly covered with lodgepole pine, generally with little undergrowth. There are zones, however, where undergrowth seem to be more lush than the average, (e.g. at approx. 600 ft. and 150 ft. above the base) and these spots are associated with delayed drying of rain water, possibly seeps. Actual, reliable discharge of groundwater, however, was not found.
Near the top of the mountain the vegetation seems rich, possibly (confirmed by tower man) due to increased precipitation with altitude.
According to tower man, runoff of rainfall is relatively little, water seems to infiltrate readily.
General impression is flow systems are active, but geology provides for diffuse discharge. Intensive diffuse discharge is evidenced by uniform, rich vegetation. (Rainfall, however, may be a more important factor in determining the type and uniformity of vegetation, here).

88 Spring
Semi-circular depressions at foot of small, pine covered hill, along Hwy. Floor of depression is boggy, swampy, with thick moss cover. Permanent looking discharge.

Sketch – stop 88



Water flows out of gravel at approx. 100 gpm (measured).
(Water sample 88)

T=38°F C=70 µmohs/m Q=100 gpm

The whole area, Elk Creek valley is characterized by small, round hills. On the west side of the hill NE sloping beds outcrop. Often seeps noticed also (visual-while driving).
Photo 8

Stop 88-8

89 Spring
Water coming out of muddy black shale. Typical (and excellent) example of permanent discharge area.
(Water sample 89)

T=39°F C=450 µmohs/m Q~3 gpm (visual)

(May be diluted by rain, but is definitely permanent discharge from bedrock – no gravel cover.)

90 Well water – South Ram River Campground
Local high, flat, with uniform pine growth
(Water sample 90a)

T=37°F C=370 µmohs/m

90b Spring water
Major permanent flow

T=37°F C=370 µmohs/m Q~100 gpm

91 Spring
Permanent flow, in road side embankment. Slumping is associated with this concentrated and obvious diffuse discharge. Water runs out of and through rock debris, which is covered by moss, algae, etc.
(Water sample 91)

T=38°F C=160 µmohs/m Q~20 gpm measured

91a SW facing slope, exposed, yet phreatophytes. Probably recent rain water is mixed, although no contribution via surface channels could be detected. Short, intensive, variable system.

92 General observations
Pine forest with heavy sphagnum moss ground mat. Sedges, alder, and other broad leaf phreatophytes. Few clumps of black spruce,
In slight depression of sphagnum small typical rainwater pool, i.e. grass under water.

T=51°F C=345 µmohs/m

The area looks to be the counterpart of the prairie "neutral" –feature areas.
At next spot, water stands on clay in roadside ditch, obviously derived from rain.

T=65°F C=490 µmohs/m

Very general change, no specific phenomenon observed between **92** and Sask. River.
Thick alluvium high up the valley. 20 ft. deep gravel pit along road: dry.

93 North Saskatchewan River
(Water sample 93)

T=54°F C=185 µmohs/m

Photo 9
Photo: River at Nordegg

94 Spring
Water discharges from small hole in grassy, phreatophytic road side, on south side of Hwy. Sign "Water" nailed on Hwy turn sign indicates spring site. Mosses, signs, etc. indicate that spring is perennial.

T=48.5°F C=420 µmohs/m Q=0.1 gpm

Small yet perennial flow.
On north side of the road outcrop of strongly fractured very fine grained (a crystalline?) sandstone or (limestone?).

95 Spring – south side of Hwy 11
Phreatophytic environment; spring is marked by mature black spruce grove. Spring used to be used for water supply; wooden trough, cribbing still present. Also (according to Baseline Tower man.) Narrow, (30 cm) deep, (30 cm) meandering channel conveys water away from actual hole. After approx. 4 mi. water disappears underground. Channel is cut into travertine terrace.

T=39°F C=600 µmohs/m Q~0.1 gpm

96 Extensive seepage
Large area under water, similar to a big slough, with aquatic and phreatophytic plants. According to tower man "spring" here is perennial. Numerous game trail leading to the place testify to this.
(Water sample 96)

T=54°F C=590 µmohs/m

Wednesday, July 31 1968

Trip to Jackfish Lake – Camp creek area.
Thickly wooded, approx. even mixture of pine, spruce, poplar, aspen. Willow and Labrador tea common. Area is generally moist, which aspect is emphasized now by recent heavy rains. Large portion is covered by alluvium; rounded coarse gravel, clay.
On the basis of the general picture obtained so far, it seems more certain than before, that the Province's groundwater evaluation will have to rely very heavily on theoretical work. Lack of access, heavy cover, low density or non-existing population resulting in a lack of any actual information, precludes the possibility of compiling factual information and evaluating it.
A comprehensive, and quantitative definition of the concept of Hydrogeological environment, the formulation of the therefrom derived groundwater regime, and its application to the various parts of the Province will be more "célravezetö" (fruitful) than actual data compilation, for very large tracks of the Province.
The idea of "establishing Hydrogeological provinces", and carrying out detailed, type studies to obtain the definite, quantitative characteristics of each province, which subsequently are taken valid for the whole hydrog. province seems to be very strongly endorsed by experiences of the present work.

97 Traverse / Section over hill slope
(a) Pool of surface water
Poplar, aspen, willow, with few scattered spruce. Rich ground vegetation. Few small ponds in surface depressions observed. Obviously derived from recent heavy rains.

T1=52°F C1=65 μmohs/m
T2=52°F C2=68 μmohs/m

(b) Pool of surface water
Approx. 400 m north and 75 ft. higher than **97**.

T=54°F C=50 μmohs/m

Top of the hill (North end of traverse) very heavily vegetated, with alder, willow, and other shrubs; broad leaf and large grassy plants. It is a burnt over area with probably mixed pine, spruce & aspen the climax vegetation as seen in other similar areas. The general impression is that of plenty moisture even on the hill tops. However, little or no indication of surface runoff (no well developed gullies), rounded smooth hills.
On the south end of the traverse there is muskeg with tamarack center and relatively little water.
Discharge probably takes place in a diffuse manner, as the lack of springs, lack of excessive water in the muskeg, and the small size of a known springs (**94** to **96**) indicate.
Characteristics of this area: high annual rain fall (over 24"); little surface runoff; little but marked change in vegetation from high to low (generally moist conditions); no major concentrated discharge points.

Conclusions:

1. High precipitation; no surface runoff: high infiltration.
2. High infiltration; no concentrated points of discharge; muskeg conditions without excessive amounts of water; perenniality of every small seeps and springs: medium intensity, permanent (low variability) flow systems; diffuse discharge.

98 N. Sask. River
(Water sample 98)

T=51°F C=225 µmohs/m

Deep vertical exposure of Paskapoo sandstone beds on E bank. Seeps, also marked by vegetation.

99
(a) Hill top
Evenly mixed, dense even high, spruce & aspen stand. This kind of forest, with flowering broad leaf plants and shrubs, mainly alder, seems to recur on many hill tops, often with an even admixture of pine. Would this be a recharge area association? For this type area (Frontal Plains!) underlain by clay & gravel (alluvium). Birch, gooseberry. Ground is firm, stunted horse tail, no moss carpet.
(Collection of most striking plants)

A 60 cm deep hole was dug. Under approx. 10 cm of organic soil fine yellow sand. Sand is sluffing, and water percolates in hole rapidly. In approx. 15 min, 15 cm of water come into hole. This water is obviously percolating from the surface; infiltrating water from last days' heavy rains.
Since no impounded bodies of surface water are found it is assured that infiltration is rapid. Yet, due to high annual precipitation even recharge areas (like this one) have high water content, and lush vegetation.
(Water sample 99a)

T=50°F C=320 µmohs/m

(b) Down hill
Rich vegetation, good growth of horse tail.
A repeat of the situation so commonly encountered in the Frontal Plains: on the basis of the environment one is certain to find a spring or seepage; yet the ground is moist but no concentrated discharge.
This is one of the reasons that the feeling of a "diffuse discharge" develops here **{Dr. Tóth's notes in margin: "highlighting 2009 Sept. 18"}**

(c) Pool of impounded rainwater, halfway down slope:

T=81°F C=155 µmohs/m

These surface pools contain large amount of suspended sediment, clay, etc., which imparts a yellowish, milky colour to the water.

(d) Pool of surface water:
Must be site of permanent seepage: cattail, rushes, frog. Game track:

T_1=78°F C_1=320 µmohs/m
T_2=57°F C_2=600 µmohs/m

No. 2 sample was obtained from impounded body of clean water under the road, beneath the cattail pool. Again, permanent seepage is indicated but sample is most probably diluted by rainwater.

100 Sand dunes **{Dr. Tóth's notes in margin: "South of Crimson Lake turn off, ~ 1 to 2 miles"}**
Marked and very typical change of vegetation over the individual dunes.
Top: Pine, aspen, open stands, little ground vegetation
Bottom: Black spruce, willow, tamarack; sedges, juncus, open water.

Thursday, August 1, 1968

101 **(a)** Water well
(Water sample 101)

T=40°F C=580 µmohs/m

According to the rather uncertain report of the owner, the water probably comes from sandstone, the well is approx. 50 to 60 ft. deep. There is never a water problem.
(b) Flowing well
Depth: 60 ft.
Water stands about 1 ft above the surface in steel casing. Level fluctuates 6 of 7 feet with dry and rainy years.

T=61.5°F C=300 µmohs/m (dilution by rain water is probable)

Well is located in aspen-poplar, willow grove, on the edge of grassy meadow with rich sedges along creek. The area is the bottom part of a broad / wide plain.
A perfect counterpart of the prairie basins, both regarding shape and size.
Most of these basins have muskeg, stunted black spruce and even tamarack growth at locations equivalent to the prairie sloughs (poplar, willow). **{Dr. Tóth's notes in margin: "Useful comparison (2009 Sept. 22)"}**
No phenomena indicating saline (alkaline) conditions have been observed..

102 Water well
Depth 90 ft.; Water level: 50-60 ft.
Out of sandstone; Q>5 gpm. (pump capacity)

T=59°F C=700 µmohs/m

The broad, flat hill top is much drier than the valley flanks and bottom. Grain is lush, well developed.
Owner does not know of alkali soils.
Important: The difference in appearance between recharge and discharge area is more marked than on the Prairies. Probably because of higher permeability (same as sand dunes!)

103 Water well
Depth: 90 ft.; good supply; "water just soaks into ground", "no alkali soils".
Send report: (*name and address removed for privacy*), Condor
House well water
T=49°F C=900 µmohs/m
Direct from pump:

T=48°F C=900 µmohs/m

104 Soap hole

Large area of active seepage (~25 x 50 m) is fenced off to prevent cattle from getting stuck. Area is covered by lush sedge and juncus growth.
Surface is shaky, soggy; resembles membrane or blister. At centre it forms slight mound; ill defined channel leads out of it into nearby (20 m) creek.
No water sample could be obtained because of the diffuse nature of the seep.
According to owner at (**103**), there are several springs around Condor. Large icefield builds around this one in the winter.
Photo 10
Photo: Soap hole with mound, willow, juncus (centre dark grey) sedges (brown).

105 Water well

Send report: (*name removed for privacy*), Raven
Dug well was: 35 ft.
Drilled inside to 175 ft.
Water level in dug well fluctuated from top to bottom. In drilled well water level comes to within 6 ft. of surface.
Water from quicksand & sandstone:

T=56.5°F C=1180 µmohs/m
Supply is mediocre.

106 General observation

Countryside is very gently rolling. Open water depressions with moderate density (in every ¼). Little change between **105** and **106** in general appearance.
Vegetation is mainly aspen, willow, Spruce is sporadic only. Wet depressions are not characterized by spruce anymore.

107 Stock well

Depth 92 ft.; Water level: 6 ft; Q<5 gpm

T=42.5°F C=1000 µmohs/m

From general remarks: water availability is not good: "There is no well that could pump 7 gpm"; several of owner's wells have gone dry. "There are no springs in the area"; "Dug wells hold water as long as there is surface moisture".
"Some neighbours drilled four to five wells before hitting enough for the house".

108 Water well

Depth: 142 ft; Q=1.5 gpm (timed)
It could not be pumped faster for any length of time. Complains about lack of good water.

T=45°F C=1060 µmohs/m

Water has been analyzed before and "it was high in soda". They have "gumbo" and some alkali soil on the south quarter.
About ¼ mi. south of the farm yellow, "unfertile soil" patches in ditch.

109 Water well
Sand dune area.
3 wells on property. Depths ranging between 90 and 120 ft. No problem with supply. No springs known, but has alkali patches on land.
Stock well:

T=43°F C=820 µmohs/m

Prov. Analyst:

TDS: 606	Alk: 470
Ignl (Ignition loss): 70	Fe: 0.25
Hardness: 65	Nitrite: 0
Sulphates: 36	Nitrate: 0
Chl: 4	Soda 30 gr/gallon

House well (90 - 100 ft)

TDS: 784	Alk: 220
Ign: 32Nat.	Alk: HCO3 (Ca, Mg, Na)
Hardness: 30	Nitrite: 0
Sulphates: 288	Nitrate: 0
Cl: 14	Iron: 0.27

Salt precipitates
In roadside ditch, by uneven crop growth, solonetzic soil structure with white precipitates.

111 Water well
Depth: 200 - 250 ft.

T=54°F C=1040 µmohs/m

112 Water well (by (*name removed for privacy*))
(*name and address removed for privacy*) (Service station, Store)
Depth: 85 ft.; Water level: 8-9 ft.; good well
(Pressure system)

T=49.5°F C=940 µmohs/m

113 Permanent slough
Presently containing much surface water as indicated by submerged vegetation. Probably discharge of local systems.

114 Water well
Depth: 220 ft.; good supply

T=52°F C=650 µmohs/m

Well site is located at the first major terrace under high hill tops.

115 Water well on hill top
7-8 minutes pumping before water appeared (deep water level)

T=45°F C=1060 µmohs/m

116 Shady Spring Farm
Well: depth 60 ft. *(Landowner name removed for privacy)*

T=48°F C=900 µmohs/m

Soap holes, springs, muskeg with spruce, poplar, muskeg mosses. During wet years the hill side oozes. Typical discharge area of intensive flow system. Very noticeable change from hill top. Flowing wells and other springs reported along base of hill. No indication for alkali soils. 40 acres of seepage.

117 Water well
Depth ~100 ft.

T=50°F C=1000 µmohs/m

118 Spring
Water is discharged through pipe into cattle watering trough. Dense spruce & poplar growth, hummocky, even muskegy ground. Various flowing wells reported. Typical discharge area. Seeps noticed in abandoned yard.
(Water sample **118**)

T=43.5°F C=920 µmohs/m Q=1.5 gpm

Muskegs in general region (at base of Medicine Lodge Hills)

Friday, August 2, 1968

119 Water well
Depth: 85 ft; Water level ~30 ft; Aquifer: gravel; good supply

T=47.5°F C=780 µmohs/m

Springs along both sides of Blindman River. One on east side deposits heavy tufa. No alkali soils in vicinity. River valley and flanks have willow, poplar, spruce.

119a Reported spring

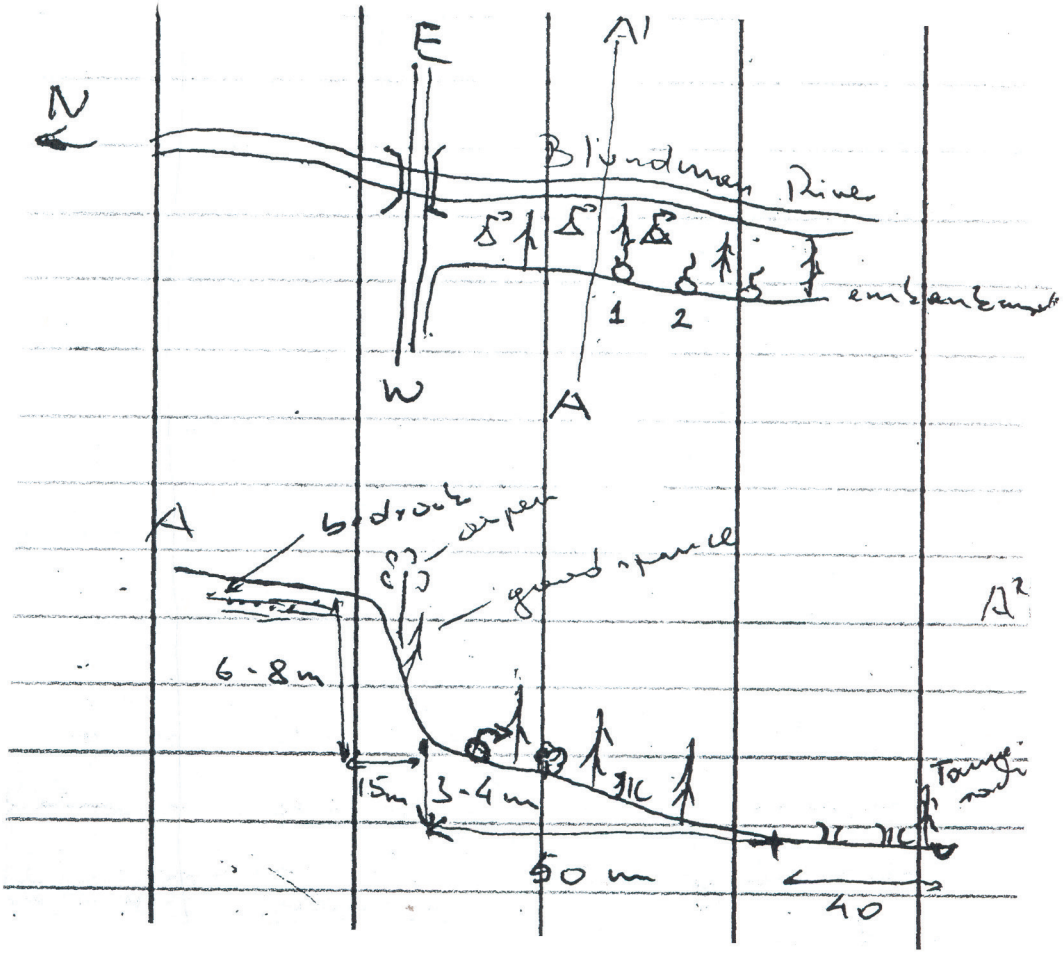
By owner at **119**. Vegetation runs similar to that at **120**. Reported travertine.

120 Springs & seeps

Stream valley south of the highway is a definite, marked discharge area. Starting at the road going south valley is very moist boggy. Vegetation is surprisingly similar to the Foothills and Frontal Plains muskeg: stunted black spruce, good black spruce, thick moss mat, alder, sedges, Labrador tea, willow tamarack.

T=43°F C=680 µmohs/m
T=45°F C=700 µmohs/m

Seepage is obvious.
From the flat bottom of the valley, floor rises gently first, then abruptly, with an embankment it just approx. 6 - 8 m;



Sketch – stop 120

Approx. 400 m south of Hwy, first actual spring appears, 50 m farther, second.
Travertine deposit in discharge channel.
Springs seem to issue out of bedrock: med. coarse buff sandstone. Channel development indicates permanent flow (same as report)

T_1=43°F C_1=680 µmohs/m Q_1~1-2 gpm
T_2=45°F C_2=700 µmohs/m Q_2~2-3 gpm

121 Water well

Depth: 195 ft.
Water occurs at 90 (Water level: 40 ft in 90 ft well), after 195: Water level: 70 ft.
Hard water at 150; soft at 195.
Two miles north all sorts of flowing wells (**120a**)
No alkali soil in definitely closed surface depression.

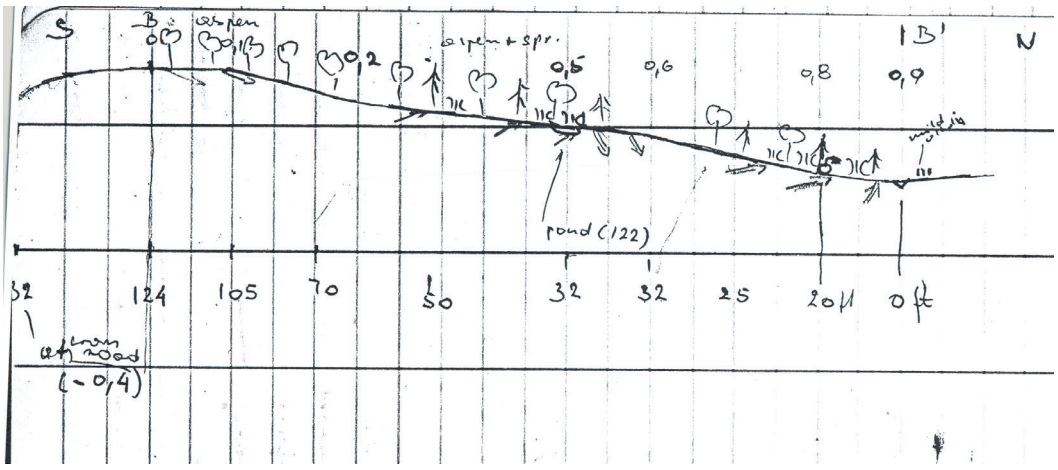
T=50°F C=1010 µmohs/m

122 Permanent slough (pond)

Small 20 x 20 m closed depression at downslope end of aspen & spruce grove. Bottom of grove is wet, moss covered, rich phreatophytic and willow vegetation.
Cattle pond has no vegetation at bottom, except a few cattails and hydrophytes. Presently some of the shore vegetation is submerged indicating risen water level due to heavy recent rains.
Area is undoubtedly indicative of discharge from the hill top through a local system, which shows that local systems are operative even in this environment. This just like in the mountains may explain the repletion or even reversal of chemical quality changes.

T=61°F C=250 µmohs/m

(Situation is analogous to Trochu flowing well – alkali – rush seep corner)
Between 0.5 and 0.6 mi. land becomes relatively dry, no spruce mixed with aspen. At 0.7 spruce appears (on east side of road where bush was not cut). With a gradual but very marked change vegetation becomes entirely phreatophytic by 0.9: aspen, spruce, tall alder, Labrador tea, horse tail, mosses, and broad leaf flowering plants in a rich, damp growth.



Sketch – stop 122

On the west side of the road, where the bush has been cleared, the corresponding change (?) in moisture conditions is reflected by a change from rich pasture grass to very lush and dense sedge and juncus growth. At the place these changes take place water starts to issue in roadside ditch from the ground forming a continuous flow in a well established, locally moss lined channel to creek at 0.9.
Important: all these changes occur over an evenly sloping surface!
Immediately north of creek (0.9) oats is stunted, uneven, yellow: mild alkali soil development.

123 Spring

In typical discharge environment (black spruce, mosses, tamarack, etc.) water issues through seeps, and spring hole in moss carpet.

T=40°F C=640 µmohs/m

Owner states "slow seeps" occur full mile north on his property.
Water is conveyed through iron pipe, flows during winter, is sole supply of land owner.

124 Spring

(*Name and address removed for privacy*)
Water issuing out of several holes radially arranged around circular depression of approx. 3 m in diameter in hill side pasture. Well defined creek like channel conveys water to creek approx. 100 m away. Flow is permanent.
(Water sample 124)

T=43°F C=750 µmohs/m Q>150 gpm (visual)

Adjacent (to south) quarter section is seeded to crop which is in excellent condition; seems to be fed by seepage.
Photos 11-13

Stop 124-11

Stop 124-13

Photos (3): Spring and discharge channel.

Owner has pointed out and mentioned various features which indicate "hidden seepage", "show seepage", "underground springs". All the features mentioned and shown I have noticed and noted before. His remark corroborated and confirmed my previous observations.
"Crops will grow well in areas of hidden seeps even in years of drought."
Pointing to an even, straight grassy slope between crop and muskeg: "This field has the same surface drainage as the one higher, yet, after clearing it from the spruce and aspen forest, we could not farm it because the equipment, even horses would get bogged down, as they break through the top ½ or 1 foot. This is due to a heavy underground seepage."
"You can tell hidden springs by the type of tree."
The whole area is clearly one of discharge, ranging in phenomena from good crop growth in dry years to muskeg, seeps, springs, and flowing wells.

Neighbour farmer tells that the average well depth in the area is approx. 60-70 ft; with water levels 6 - 8 ft below surface.

125 Closed moist depressions

Several closed, moist depressions observed in freshly broken extensive fields. Plough had to go around some of them leaving the original spruce & aspen standing in small circular spots. These clumps of spruce & aspen appear to correspond with the willow rings and rush – alkali, moist depression on the Prairies, which indicate midline area conditions.

126 Closed intermittent pond

On top of hill, willow ring with approx. 30 cm of water in it. Hard bottom submerged sedge vegetation, homogeneously covering ring bottom.

T=69°F C=130 µmohs/m (as opposed to 250 at **122**)

Saturday, August 3, 1968

127 Spruce grove

Starting approx. 0.6 miles S of bridge spruce & poplar bush. Bottom is firm, although wet, with open water even, at spots water is of rain. Sedges, mosses locally. On sandy hills pine. Towards creek bottom becomes even firmer; may be due to deforestation for grazing purposes.
Tree vegetation (dwarf alder) suggestive of discharge conditions but bottom lacks the lush appearance, although definitely moist. (Cattle may play a role in tramping down and solidifying the ground). Also, bottom is like the usual thick moss mat, and sogginess. (Probably due to sandiness).
In sample pit dug to approx. 1½ ft. med. coarse, slightly argillaceous sand, moss found.

128 Water well (dug)

(*Name and address removed for privacy*), Blufton
Well depth: 33 ft., Water level: 30 ft.; good supply

T=41.5°F C=600 µmohs/m

129 Spring

Perennial flow of water out of several openings in circular depression.
Ground is very sandy and firm even in the immediate vicinity of the area of emergence. The area itself, however displays soap hole conditions. The general area is very moist, with thick mat of moss (despite the presence of cattle), black spruce, poplar, tamarack, Labrador tea, sedges, pine.
(Water sample 129)

T=43°F C=480 µmohs/m Q~1.5 gpm

Photo 14-17

Stop 129-14

Stop 129-16

Photos: (1) spring
(2) Discharge area vegetation in a parkland environment with sandy soil: **{Dr. Tóth's notes in margin: "highlighted: 2009 Sept 22"}** spruce, black spruce, pine, tamarack, willow, Labrador tea (even on sun exposed parts), mosses, sedges.
Spring flow goes back into ground after about 10 m overland flow, only to reappear at a higher rate in roadside ditch approx. 10 m farther.

130 Embankment in hillside

Steep but low (5 m) sharp rise following contour line on hill side. "Frontal Plains" at "knick point", or at base obviously moist. Spruce, etc.
Series of local systems similar to the one at **122**.

131 Knob and Kettle sequence

Alternating hills and closed depressions (few tens of meters), in sandy, pebbly material. Vegetation is extremely mixed.
Hill tops are dominated by medium-developed aspen and have rather sparse but not typically dry grass and shrub vegetation.
Depressions have lush, mainly broad leaf sedge cover, cattail, and locally open water, spruce, pine.

T=59.5°F C=170 µmohs/m

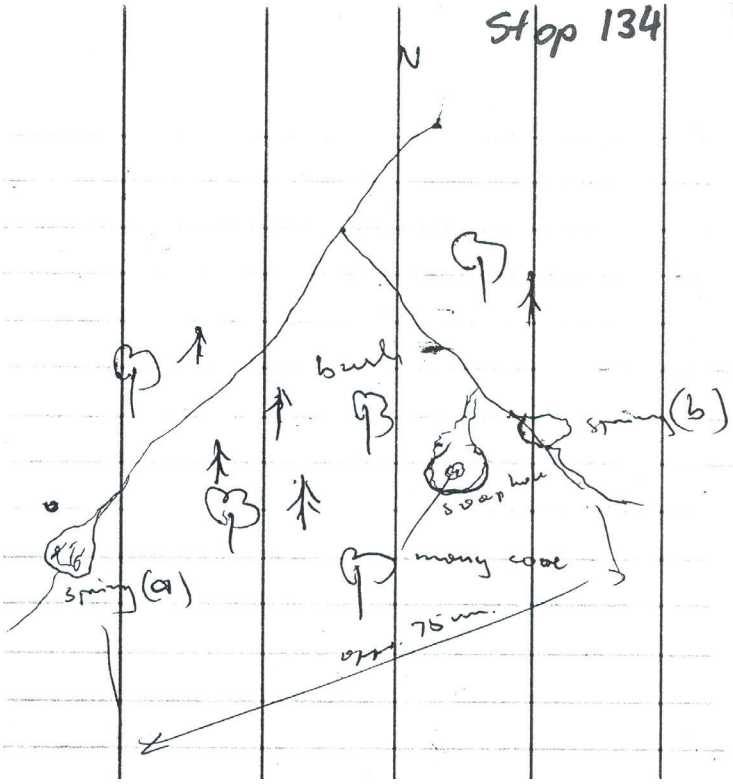
The impression is that this area is an example of "sloughs" changing hydraulic character with the season: receiving groundwater during summer & fall from the surrounding hills, and recharging the groundwater systems during spring break up.
The whole area, however, on the average, would function as one of recharge.

Photo 18
Photo: Cross section of local hill: aspen on hill top (left), spruce towards bottom, water (T&C measured) in foreground depression with broad leaf sedges, and willow.

132 Broad hills and depressions
Same remarks as for 131, but on a larger scale: depressions are resembling dry muskeg, with black spruce and tamarack, hills covered by aspen. (Size few hundreds of meters)

133 Hill-Side Hill
Repeat of previous observation:
Top: aspen, evenly sloping side hill, without chance of surface water to get impounded gradually becomes increasingly moist. Aspen changes into mixture of aspen, birch, spruce (well developed) pine, and goes over into spruce, black spruce. Also, sedges and mosses, Labrador tea appears on lower part of slope.
Length of traverse discussed: approx. ½ mi, elevation diff.
~50 - 75ft.

134 Springs – soap hole – seeps
Two springs approx. 75 m apart with a soap hole in between them discharge water permanently into very well defined, permanent stream channel. Creek bed continues uphill but is dry.



Sketch – stop 134

Typical phreatophytic vegetation (see down slope 133), with thick moss & sedge cover at points of discharge. Top of soap hole is formed by a moss layer, which behaves as a membrane: quaky, bulging. Travertine chips found in discharge area of soap hole. Also, some slimy, yellowish, fibrous growth noticed at various points, reminiscent of yellow algae found in sulphur spring. A very faint sulphur odor is thought to have been smelt.
Soap hole is located on the upslope portion of a circular clearing in the bush. (Water sample **134a**)

T=42.5°F C=620 µmohs/m Q=2-3 gpm

Flow increases all the way along the channel indicating increased discharge in addition to flow from spring (b) and soap hole.

Spring b:	Q=1-2 gpm
Soap hole:	Q=1-2 gpm
Total flow:	Q=20-30 gpm

Photos 19-20

Stop 134-19

Stop 134-20

Photos: (1) soap hole – showing mossy core
(2) soap hole, with soft depth indicated on pole by Richard's hand.

Seepage observed at roadside.

135 Photograph

Photo 21
View to the south across Muskeg Creek.
Dark vegetation at bottom part and lower slopes is mainly spruce, containing seeps and springs. Top is aspen.
Distance between 1.8 m point of picture and opposite hill:
Relative relief ~300 ft/mi.

136 Traverse – South of Battle River Bridge (Driven by car)

Distance (mi)	Elev. (ft)	Hydraulic type:
0.0	0.0	·stream
0.1	0.0	·
0.2	10.0	·base of knick
0.3	25.0	·o edge of knick
0.4	40.0	·x--“--
0.5	35.0	·o edge
0.6	50.0	·
0.7	45.0	·
0.8	50.0	·base of knick point
0.9	55.0	·--“--
1.0	80.0	·x lower edge of knick
2.2	225.0	·x

137 Water well
Depth: 156 ft.
On hill top

T=48°F C=645 µmohs/m Q>6 gpm (good)

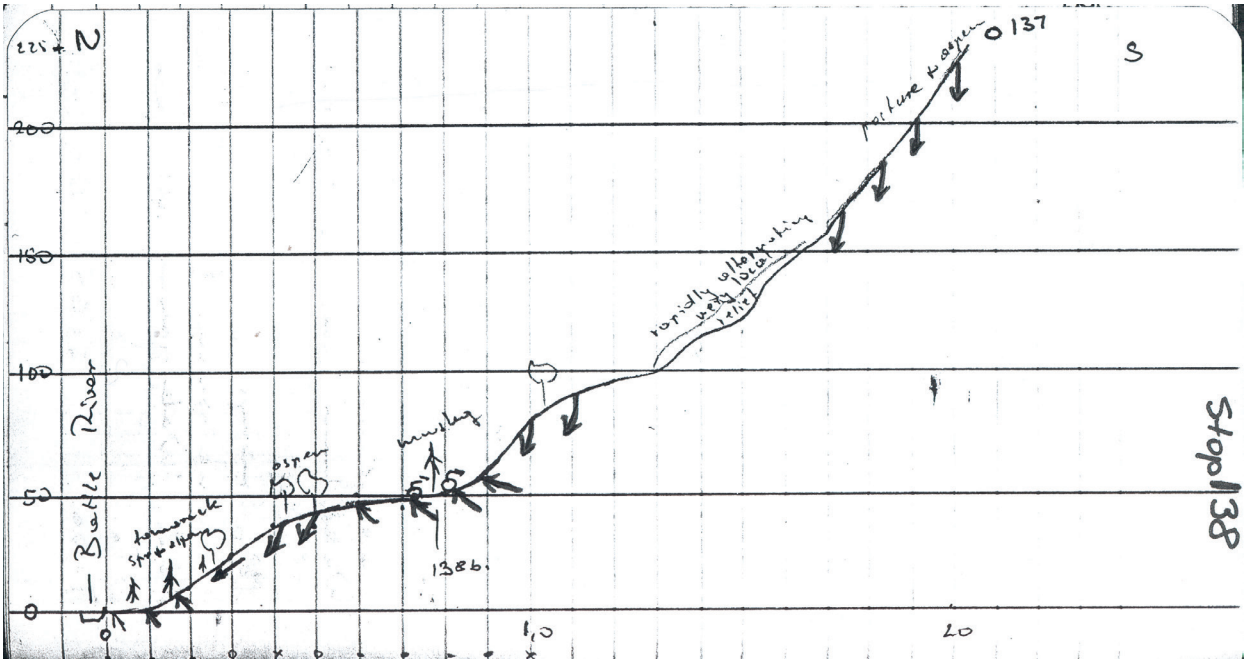
138
(a) Water well
Dug well; 19 ft deep; Water level 16 ft.

T=56°F C=630 µmohs/m Q>10 gpm

Water from fractured brown sandstone.

(b) Springs
Nine springs lined up along bank. Water runs all year.

T=58°F C=650 µmohs/m Q~2-3 gpm



Sketch – stop 138

When it starts freezing, water level in springs rises approx. 1 ft. (Vegreville!)
Sandstone is approx. 4 to 5 ft from the surface, under till.

At **138c** large spring, maintaining a tributary to Battle River, is reported.

Hydrogeological Reconnaissance Mapping in Central Alberta: Rocky Mountains – Foothills – Parkland

Section A, Part 2
Field Notes

By Dr. József Tóth
August 13 to August 17, 1968

Tuesday, August 13, 1968
Lv: Elk Point at 6:00 AM

139 Upland, with willow ring
Broadly convex hill top. Willow ring: surrounded by medium well developed aspen on the outside, and willow on the inside. Centre portion is covered with a sedge & rush, evenly growing vegetation. There is open water, apparently derived from recent rains. In more shady and protected spots, like the base of willow bushes, moss grows.
The general tree vegetation is aspen, not too well developed. Ground is remarkably firm even at low, wet spots in this general area; low lands, thus not only this hill, included. This must be related to the geology. Come back for report of farmer and water sample.

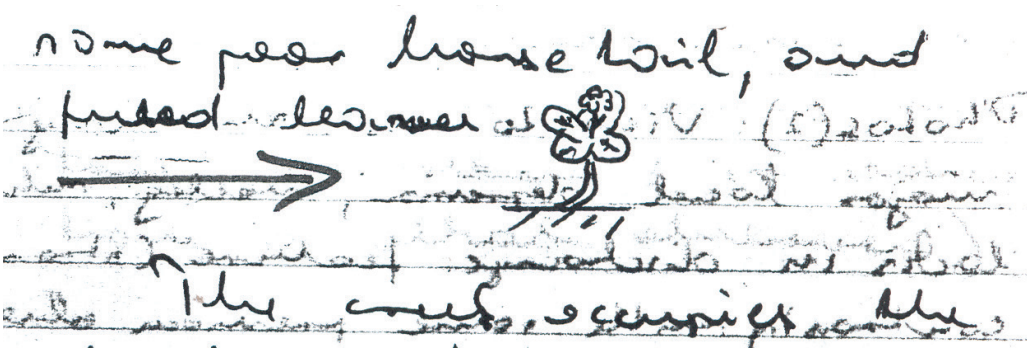
140 Depression – side hill
Little change in general appearance as compared to that at 139. Ground is firm, vegetation is the same. No open water.

141 Dugout – side hill
Extended, relatively flat portion after a drop of approx. 25 ft. in elevation from the hill top. Small dugout, with open water in it. Completely unvegetated – impossible to determine its character as to permanency. Most of its water is probably derived from rain. Cows used it, dirty, may be strongly contaminated: reading may be undiagnostic:

T=49°F C=675 µmohs/m

General surrounding is definitely more moist than hill top, although not lush. Tree vegetation is a mixed (well developed) spruce, aspen, poplar, willow & alder tree size and also shrubs. Many other flowering shrubs, horse tail on relatively dry spruce forest ground, thin moss mat, some Labrador tea.

142 Creek bed
Ground and general environment moist, due to recent rains, heavy morning fog and dew.
Stream bed is well defined, 10-15 ft. deep, 50 to 80 m across bank edges. Vegetation is mixed spruce, aspen, poplar, willow, flowering shrubs, some poor horse tail, and fused leaves:



Sketch – stop 142

The creek occupies the bottom of a major linear depression, of approx. 3/4 mi wide and 100 ft. deep. Apart from a rather well defined change in vegetation (from mediocre aspen to the mixed type specified at **141** and **142**), there is no obvious change in the moisture conditions from top to bottom. Ground is equally firm at both places; there is no indication of seeps or springs across this valley, and along a stream stretch of 200 m.
Opposed to observations made west of Hwy 2, where perennial water courses were found in small, expressionless channels, major depressions and channels accommodate only intermittent flows of water, probably associated with heavy rainfalls.
Photos
Photos (2): View to west: showing major local depression, valley, which lacks in discharge feature (strongly contrasting with some previous observations).

Photos

Photos: SE tip of Moosehills Lake. View to East from W shows 1) Lack of noticeable change in vegetation over major slope;
2) Very lush sedge vegetation (right front) with firm hard bottom (no swampy, marshy character)

143 Creek
Water discharging into south tip of Moosehills Lake. Probably intermittent flow, present water being derived from recent rains.

T=44°F C=610 µmohs/m Q>0.5 gpm (presently, visual)

In the continuation of the lake's depression and immediately adjacent to the water, summer fallow field, indicating crop farming: no excessive moisture, no alkali (no indications of alkali observed).

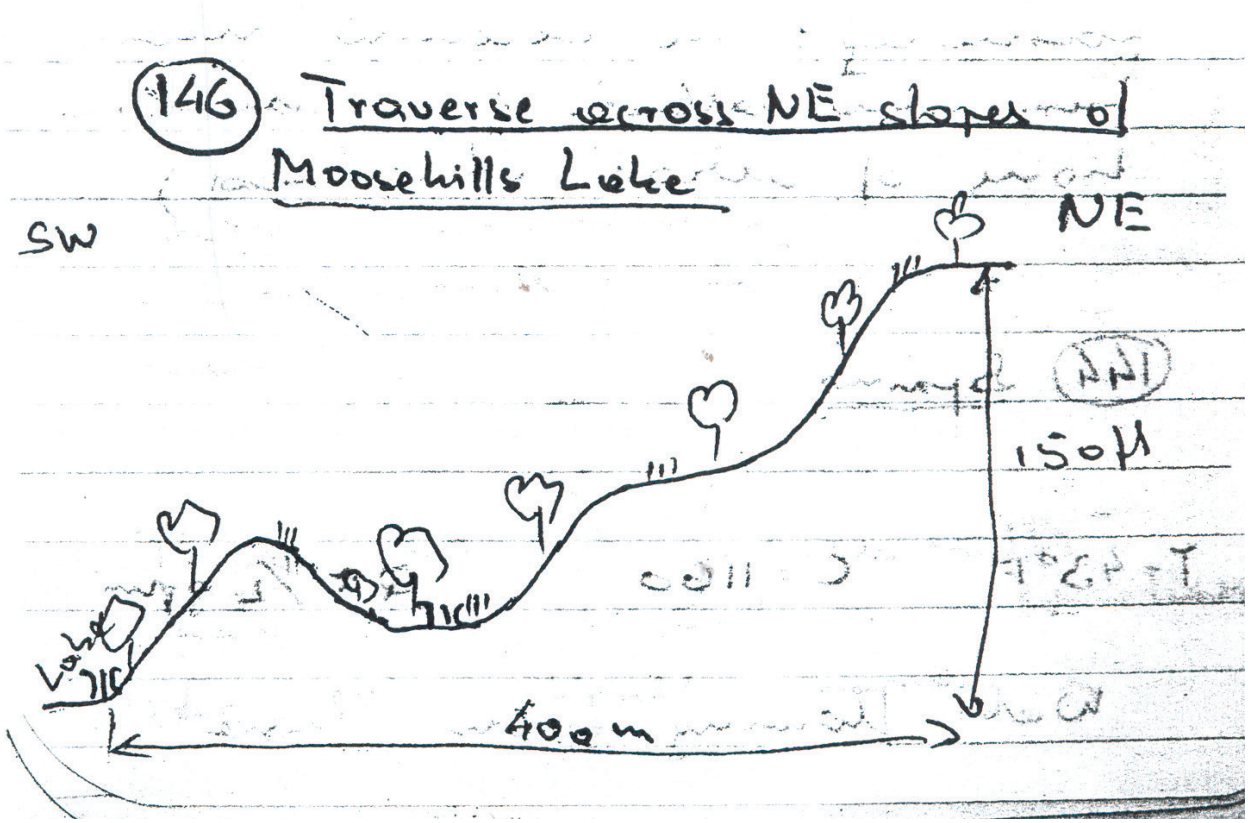
144 Spring

T=34°F C=1160 µmohs/m Q=1/2 gpm

Water flowing from base of embankment. Permanent flow. Rest of bank seeps slowly, well developed horse tails. Water level less than 8 ft. in basement of new home. Used for home water supply.

145 Reported spring
Permanent flow of water with a winter "ice-buildup" is reported at the "clump of spruce". Due to difficult access, not visited.
It is noted, however, that clump of spruce is located at the base of a long gravel-sand ridge. This material is probably the source of the other, few springs, reported in the area.

146 Traverse across NE slopes of Moosehills Lake



Sketch – stop 146

On top of hill crop grows. On the side of hill there is a coarse, very mixed, uniform vegetation of dwarf shrubs, grass, and broad leaf flowering plants. Before fire, hill was covered by poplar.
There does not appear to be any difference in the moisture content of any part of the slope, knick point, straight hill, or edge of terrace. Only at the closed depression there is some water collected.
The SW flanks of the valley exhibit a very uniform cover of aspen (or poplar) right down to the water's edge from the hill tops.
Photos
Photos (2): showing uniform vegetation on steep valley walls in a low permeability environment: SW flanks of Moosehills Lake.

These observations, when compared with those made in the Bentley area, e.g., show eminently the important role groundwater plays in the control of vegetation types, and the distribution of types within the valley. This in turn offers the possibility of arriving at conclusions regarding the groundwater-regime (flow rates, etc.) by observing the distribution of vegetation.
This traverse indicated no visible signs of groundwater discharge. Discharge must have become "diffuse" to the extreme. Diffuse and slow.

147 Water well

Bored, depth unknown; Water level:23 ft.

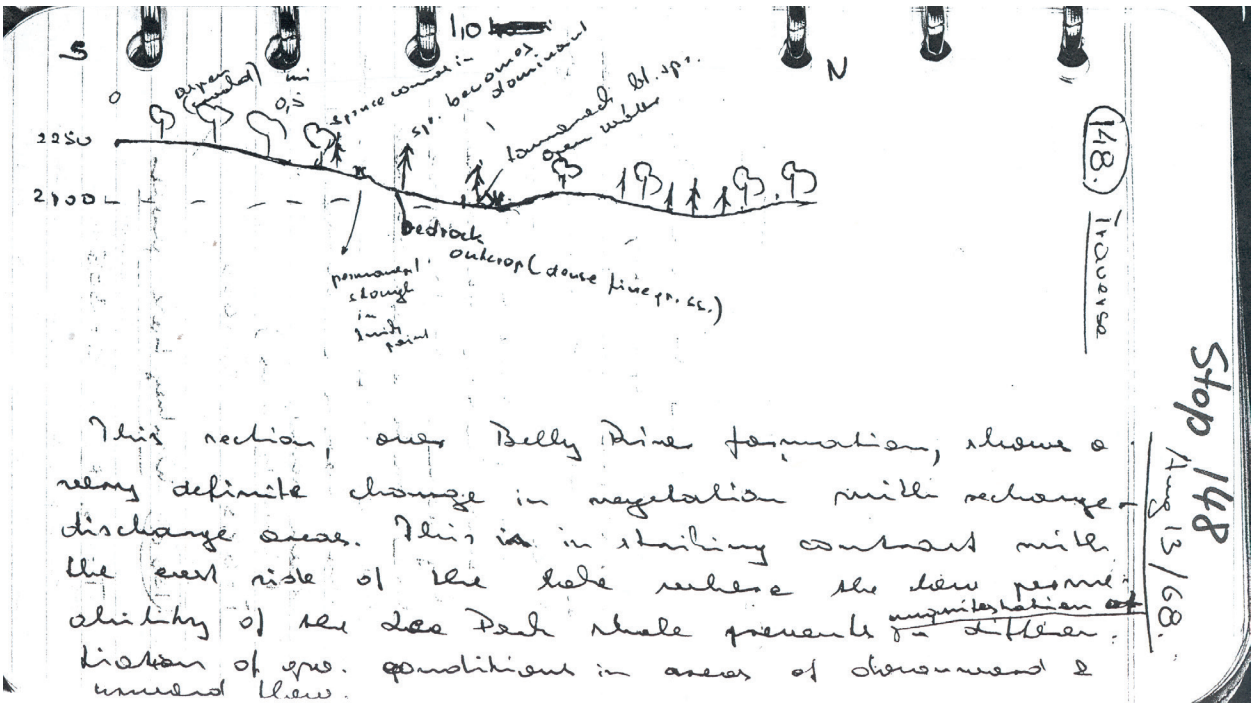
T=45°F C=2400 µmohs/m

Note contrast with water level at **144**.

Photo

Photo: Minor seep on road cut face associated with white salt halo: an evidence of groundwater transported soil salts.

148 Traverse



Sketch – stop 148

This section, over Belly River formation, shows a very definite change in vegetation with recharge-discharge area. This is in striking contrast with the east side of the lake where the low permeability of the Lea Park shale prevents manifestation of differentiation of groundwater conditions in areas of downward & upward flow.

149 Well

Depth: 28 ft. Water level: 13 ft. bored

Quicksand, water coming in at 28 ft. Can pump it dry, not before (approx. 5 gpm)

T=40°F C=800 µmohs/m

150 Lake North of Whitney
Hilly sand dune(?) area. Top of hills: jack pine, poplar; lower slopes: pine, spruce, poplar, willow. In bottom depressions sloughs, lakes.
One of these is **150**. Sandy bottom, surrounded by sandy hills. Shore is lined with a very narrow belt of sedge and juncus. Near shore bottom is unvegetated clean sand.
(Used by cows!)

T=67.5°F C=1600 µmohs/m

150a Whitney lake proper

T=65°F C=385 µmohs/m

151 ____.____
Photo
Photo: Typical crooked, or "recharge area type" growth of aspen, in sand dunes, south of Laurier Lake.

Again it is noticed, that the differentiation of recharge and discharge area type vegetation is strong in the sand dunes. The principle of "deficit & surplus" is valid, and evident, due to the high rate of groundwater flow in the highly permeable clean sand dunes.
Photo

Photo: Indian home on Nipauheos Reserve 121

152 Reference vegetation
Horizontal smooth plain: where water balance is determined by an equilibrium between precipitation and evapotranspiration (without groundwater moving away or toward):
Medium to dense, medium developed aspen and poplar stand. Dense growth of shrub willow and other shrubs, flowering broad leaves, with sparse growth of sedge, Indian paint brush. Firm ground, without moss carpet, but with thin moss patches. Rich, mixed ground cover but not carpet dense.
In local depression (old dugout?) permanent water. Level is approx. 6 ft. under land surface. May be 1-2 ft higher than normally.

T=67°F C=360 µmohs/m

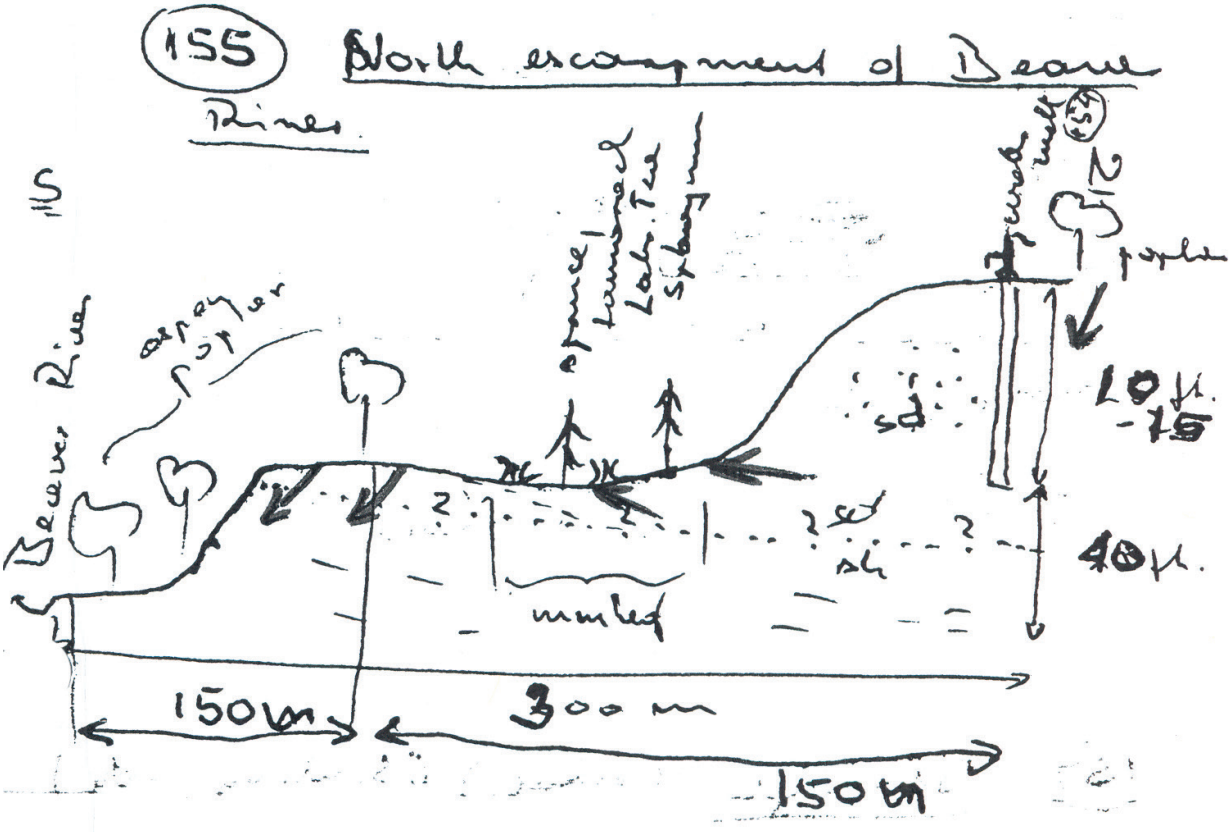
M.Sc. or Ph.D. thesis: establishing reference conditions for various Hydrogeological environments.

153 Angling lake – at Beaver Dam
Conspicuous lack of change in vegetation between lake shore (discharge) and higher grounds. Due to Lea Park shale?

154 Water well
Bored, depth=32 ft.; Water level 23 ft.
Sand
Approx. 1 gpm

T=58°F C=630 µmohs/m Q=1 gpm

155 North escarpment of Beaver River



Sketch – stop 155

At knick point of first escarpment: "permanent seep", muskeg. No change in vegetation over second shoulder and second knick point, no indication of discharge. Sand may wedge out here, leaving the low permeability Lea Park shale near the surface, with very slow discharge.
General lack of discharge features in Lea Park shale is obvious. Only steep escarpments or / and sandy ridges have some distinctive features associated with them in this area.

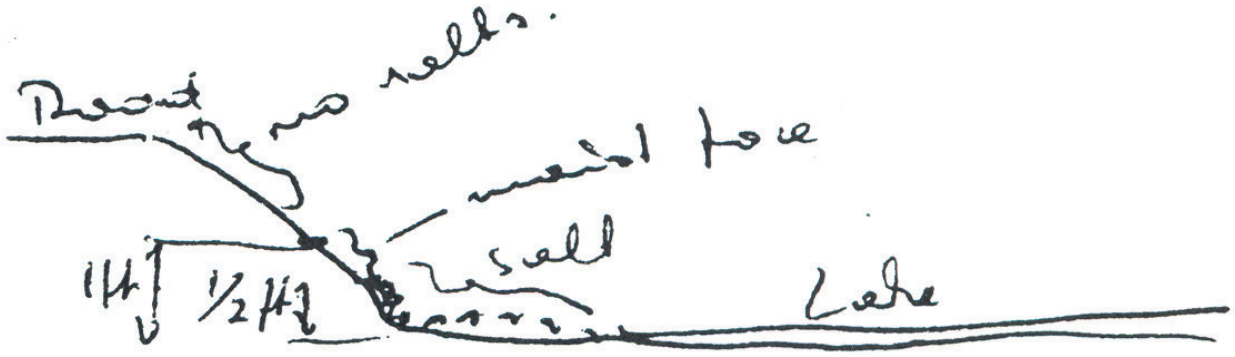
156 Highway (borrow) pit
Permanent body of water. Pit is surrounded by lush phreatophytes: cattail, giant rush, sedges, etc.

T=63.5°F C=350 µmohs/m

157 Slough (alkali) (Sinking Lake)
Large body of open water, with heavy alkali ring around water's edge.
Salicornia Rubra

T=65°F C>8000 µmohs/m

General area is gently rolling to flat.
Salt incrustations start at the base of road filling, in association with visible seepage face.



Sketch – stop 157

158 Kehiwin Lake
Long narrow, channel-lake, with pronounced banks. Vegetation does not change over the banks: uniform aspen.

T=63°F C=400 µmohs/m

Wednesday, August 14 1968
Lv. Elk Point: 2934 mi.

159 Water wells
Mr. (*name and address removed for privacy*)

(a) Barn well (drilled)
Depth: 196 ft.
Water at 190 ft from 3 ft of soft sand
Water level: 160 ft.
Supply sufficient. (Ribstone Creek Sandstone)

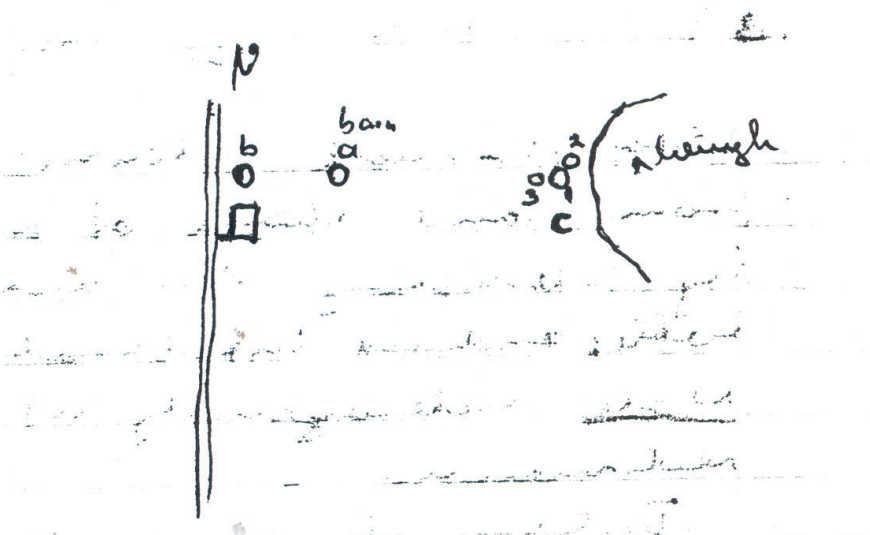
T=42°F C=1500 µmohs/m

(b) House well
Depth: 90 ft.;
Water level 60 to 70 ft.
Poor supply, no sand

T=41.5°F C=1600 µmohs/m (Grizzly Bear shale)

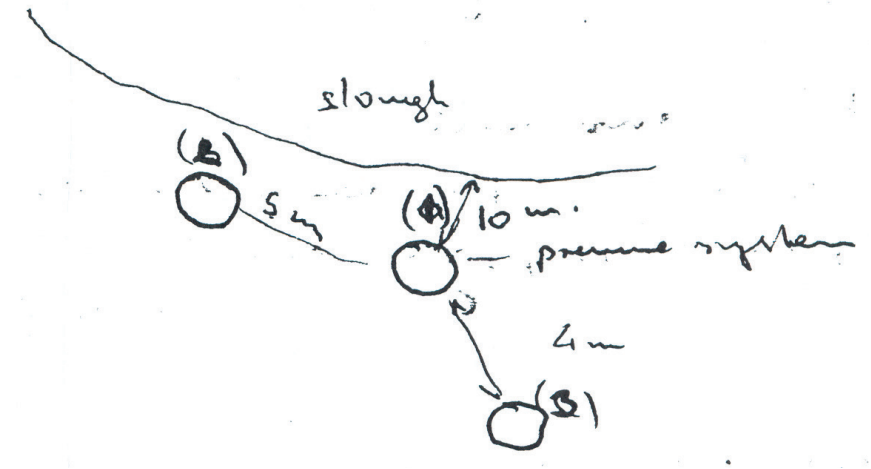
c) Slough well
Depth: 20 ft; quick sand at 5 ft from the top; Water level: 5ft from the surface. (Pleistocene sand)

T=45°F C=770 µmohs/m



Sketch – stop 159, sk.1

Slough: approx. 16 ft – 20 ft deep
Water of slough
T=65°F C=165 µmohs/m
Slough wells:
Three holes dug to 20 ft.



Sketch – stop 159, sk. 2

(1) 3 ft of clay, 17 ft of sand ; water in sand
(2) 3 ft of clay, quick sand; water, had to quit
(3) 20 ft of clay, no water

Slough-well obtains water from sand shores of pond by intercepting the water table: induced infiltration.
Note heterogeneity of surface sediments.
Recharge slough, intercepting the water table.
One mile east of slough seepage is reported – year round and marshy ground. May be the discharge area of the system originating at this slough.

160 Water well

Bored; Water level: 20 ft.

T=40°F C=1030 µmohs/m

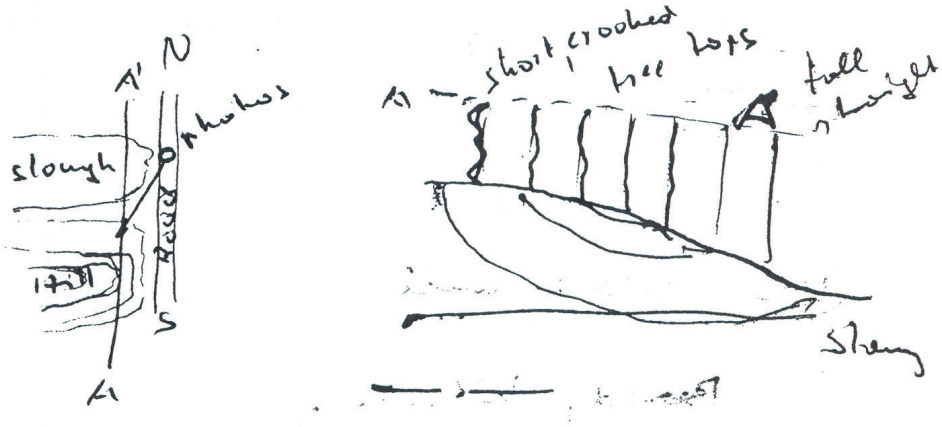
161 Traverse

No change noticed in moisture conditions. A relatively dry type of aspen and poplar growth is dominant. Drainage is well integrated but no water runs in well developed channel, indicating surface runoff character of streams.
No change apparent at mapped contact between Grizzly Bear shale and Ribstone Creek sandstone.
Topography is hilly.

Photos

Photos (3): Showing change in aspen size over a change of elevation.

Sketch – stop 161



162 Water well

M. (*name removed for privacy*) St. Paul
Depth 29 ft; Water level: 20-22 ft. used to be at 13 ft. (a drop of 7 to 9 ft.)
Approx. 1 gpm

T=41°F C=1600 µmohs/m

163 Springs

(a) T=42°F C=930 µmohs/m Q=10 gpm

Area is very hilly.

Very deeply incised channel, with rich vegetation, but only a few spruce.
Bed is sandy, rocky. Mainly flowering shrubs.
Channel was followed to fence line, but difficulty in access prevented further pursuit. Flow gradually decreases upstream. Sample taken from tributary spring, discharging at approx. 1-2 gpm.
Travertine.

T=49°F C=880 µmohs/m Q=2-3 gpm

164 Water well

Located at the base of a steep hill, approx. 10 m high (Ribstone Creek sandstone). Owners not at home, no further information.

T=44°F C=660 µmohs/m

165 Seepage

Dense willow, aspen, alder, spruce etc. growth at base of hills. Seepage with extremely lush growth of cattails, sedges, etc. This expression of discharge is attributed to its intensity due to the relatively high permeability of the Ribstone Creek Sandstone. This is in striking contrast with the expressionless, diffuse discharge common in the Lea Park shale (see Moosehills Lake notes and pictures).

Photos

Stop 165-34

Photo: (1) spruce ring with hills and aspen growth on their top. (on south tip of Lake Eliza)
(2) take from the hill side: dead wood pile is approx. 3 m above lake level: very soggy, seeping, cattails, no cultivation.

Wheat grows chest high adjacent to upslope margin of uncultivated field. Further upslope it rapidly decreases to less than knee height. Farther upslope its height (quality) varies corresponding with the observable differences in the ground moisture, and in bands, probably reflecting the stratification (permeability changes) of the underlying sandstone.
Point: discharge features are accentuated (better than in Lea Park shale) due to higher permeability.

165a Water channel – flowing water

Permanent but locally overgrown channel with flowing water, similar in appearance to spring channels of **163**. Algae, juncus, etc.
Channel comes down from high hills and is inaccessible: origin of water cannot be traced, but is most probably spring.

T=49°F C=1000 µmohs/m Q~5 gpm

It is remarkable how much influence groundwater flow direction has on the type and quality of vegetation.

166 Water well

Send report: (*name removed for privacy*), Lafond
Depth: 33 ft; Water level: 12 ft.
One year old, sufficient water. Out of shale, coal, some sand

T=40.5°F C=1130 µmohs/m

167 Spring

2 ft. diameter round hole in ground filled with water. Hole is located on side hill. Down hill at approx. 20 yds water is discharging on to road.

Spring:

T_1=43°F C_1=610 µmohs/m
T_2=57°F C_2=640 µmohs/m

General area is moist, with aspen, spruce and other phreatophytes.
Three more springs reported in immediate vicinity.
One of them:

T_3=43°F C_3=650 µmohs/m Q=1 gpm

It is used for watering cattle all year round.
These springs discharge into spruce swamp south of the place. They are surrounded by spruce and aspen. Typical, accentuated discharge area, and features. At spring site 6 ft pole can be pushed into shaky, soft, moss covered ground.

168 Water well

Send report to Mr. (*name removed for privacy*), Foisy, Alberta.
Loc: 16-29-056-11W4
Depth: 120 ft. Water level: 40 ft.
Driller: (*name removed for privacy*), Mannville Drilling Co.
Water at 100 to 120 ft.

T=57°F C=750 µmohs/m

Log:	0	-	13	clay
	13	-	86	sd
	86	-	97	sh
	97	-	98	gravel
	98	-	120	gravel, layers of shale

Tested at 8 gpm for 2 hrs.
Recovery:

After	1 min	to	68’
	5 -“-	to	51’
	10-“-	to	44’
	15-“-	to	42’
	30-“-	to	40’

General area: broadly rolling to flat upland. Stunted, gnarly aspen crop fields.

169 Hwy seep, springs

Valley flank, approx. 200 m east of bridge. Broad, evenly sloping flank, with mixed spruce & poplar vegetation. Cattail, juncus and other phreatophytic grasses in ditch drew attention to concentrated discharge in north side ditch.

Water: T=63°F C=630 μmohs/m Q~1 gpm

The spruce vegetation, with a lush but not too moist, not muskegy undergrowth is indicative of relative surplus of water in this region, where the reference vegetation is a dry (without much undergrowth) aspen type.
Associated with this vegetation (spruce, cattails) and seepage, there are cracks and a freshly repaired hole in the black top of the Hwy pavement. The edge of the black top is damp and water is observed to actually seep out from under the pavement.
This discharge is thought to be associated with a contact between shale and sandstone in the bedrock.
Note: If the differentiation of recharge-discharge features is a function of the rock permeability (among others?) then it may be used for establishing groundwater supply prospects in a general sense!

Q: Are the groundwater regimes of different hydrogeologic environments also different?
A: Yes
Q: Are the differences between the groundwater regimes of different hydrogeologic environments manifest; can they be observed and demonstrated by the way of natural features (as opposed to theories, models or well data)?
A: Yes
Q: Can the observable features be used as the basis for the reconstruction of the groundwater regime?
A: Only for the reconstruction of the regime of the top-systems, i.e. the ones nearest the surface.

But then, it must be possible to:

1. determine the hydrogeologic environment
2. derive the groundwater regime therefrom (theoretical)
3. establish the groundwater regime by surface observations (geonomical)

4. establish the groundwater regime by technical means (test drilling observation wells, etc.) (mechanical)
5. **if** there is agreement among the results of the three methods outline the boundaries of the regimes by method (1)

In connection with the present study (field work) the main point is to demonstrate the agreement between the findings (results) of (2) and (3).

Thursday, August 15, 1968

Lv. Elk Point: 7:00 AM 3068 mi.

170 Campsite at N. Sask. River

(a) River Water (sample 170a)

T=60°F C=280 µmohs/m

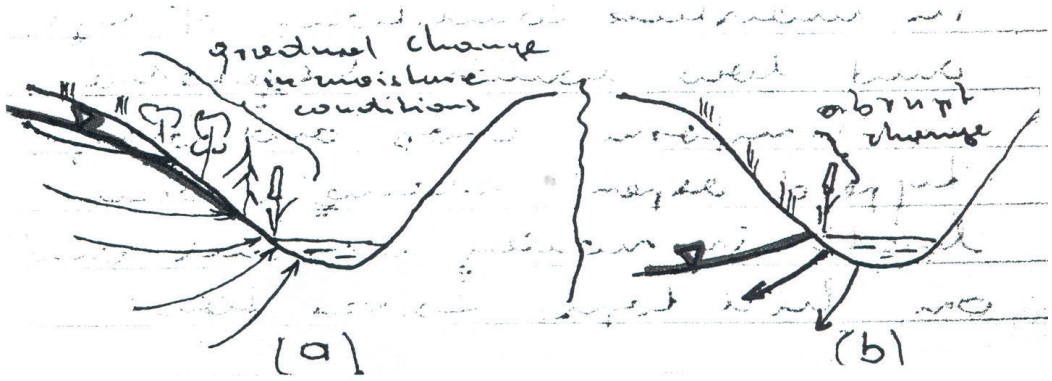
(b) Water well (sample 170b)

T=45°F C=3200 µmohs/m

No readily discernible discharge phenomenon at river bank or valley.
Poplar, aspen, thin and crooked.

171 Traverse by car

Undivided Belly River. Hilly topography with major NW-SE oriented linear features: valleys, hills.
No noticeable difference in moisture conditions of high and low lands.
Vegetation is uniform: crop and dry type of aspen. Sloughs occur both in valley bottoms and on hill tops.
Latter fact indicates low infiltration rate (as opposed to e.g. Crammond – Caroline area).
Presence of bored stock well noticed in the bottom of a draw: under conditions of high permeability spring would (or at least could) be used.
General impression: due to the negligible, if any, differentiation of recharge and discharge area appearance, it is concluded that the flow systems in the area are sluggish: poor water supply, high mineralization (could be checked out by local survey or from G. LeB.).
Possible explanation of different vegetation association at the edge of water bodies supplied by groundwater and surface sources:



Sketch – stop 171

(a) Groundwater fed: depth to the water table increases gradually away from the open body of water, due to the shore line being an area of upward flow. This condition results in a gradual decrease in soil moisture, in turn resulting in a gradual change, and a wide spectrum, with mossy intermediate species, of plant types.

(b) Surface water fed: depth to water table increases rapidly away from the body of surface water. Change in moisture conditions is abrupt: so is it in vegetation types; transitional species lacking.

172 Floodplain & valley bottom of Vermillion River

Dry appearance, hard ground, with hay (dry) on cultivated fields to water channel's edge.
Vegetation is "dry aspen", willow, with sparse and dry bottom vegetation, even in closed depression at base of steep embankment on east side of river, south of the road. Pasture grass, silver willow, sages grow on valley bottom near the channel.

River water (from edge)
Flow, if any, is imperceptible

T=62°F C=800 µmohs/m

Width of wetted channel appr: 20 m (width of water)

173 Slough

Permanent body of water in elongated, narrow (80 m at the top) deep (8 m) depression.

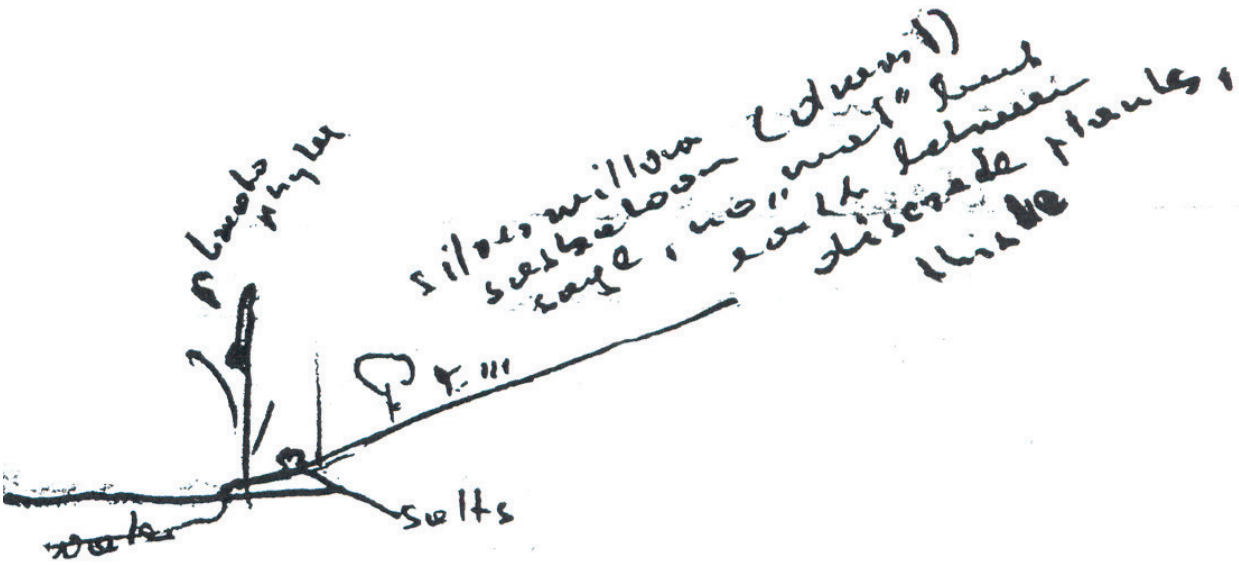
Sketch – stop 173, sk. 1

T=62°F C=1000 µmohs/m

Sharp change of vegetation of water's edge indicating surface origin of water. (see notes after stop **171**)
There is, however, groundwater discharging into the slough, as evidenced by heavy salt incrustations on a few earth clumps on the side slope.
Slope is covered by saskatoons, which, however, do not grow above knee height, in contrast to saskatoons seen e.g. on west side of Moosehills Lake, where it grows 6 – 8 ft. tall.

Photo

Photo: abrupt change in vegetation type on edge of water derived mainly from surface source.



Sketch – stop 173, sk. 2

174 Water well

Bored; depth =?; Water level =?

T=47°F C=520 µmohs/m

Shallow well, high water level; relatively rich vegetation, tall aspen, some horse tail. No spring reported.

175 Open depression – intermittent runoff channel

Runoff channel heads in open depression on east side of the road.
Depression is damp, covered with a lush growth of sedge, some juncus, mosses, willows. It is located in the middle of a fallow field. Its continuation on the west side of the road is a deep channel, heavily vegetated, poplar, willow, generally lush, etc. This is one of a series of intermittent channels radiating from the top of the major hill. The environment is sandy.
It is thought, that the base of the sand forms a low permeability boundary (= the top of the Lea Park shale). Infiltrating water is diverted and discharges along the line of runoff channel heads, or slightly down slope. Groundwater discharge – surface –erosion interaction at play.
Shallow well of **174** is probably obtaining water from this meagre but good quality supply.

Rapidly alternating expression of recharge – discharge areas, with small areal extent indicates short, shallow, relatively intensive systems.

Photo

Photos (2): taken from **175** to SW: Valley of Vermillion River showing the characteristic lack of any change in vegetation associated with groundwater recharge – discharge. This is seen on the broad scale (general view) and on the local scale as well (on left hand side of photo cross section of NE-SW running portion of valley is seen without a change of vegetation over a steep slope of the valley flanks).

176 Water well

Depth: 70 ft; Water level: 30 ft.
Soil is clayey, black “soil down here”, sandy up on the hill. Good supply (domestic well).

T=45.5°F C=2400 µmohs/m

177 Water wells

Depth: 37 ft; Water level: 30 ft.
Run dry every now and then.
Good for domestic supply.
Water out of quick sand.
(a) Dry Hole:

	0	-	1	black soil
	1	-	10	brown till
	10	-	14	yellow till
	14	-	25	brown till
	25	-	103	grey shale (Lea Park)

(b)	0	-	1	top soil
	1	-	5	brown till
	5	-	11	yellow till
	11	-	16	brown till
	16	-	40	fine yellow sand }water
	40	-	45	brown till
	---	---	---	---
	45	-	47	bentonitic shale
	47	-	49	grey shale (Lea Park)

This one produced 2/3 gpm
Water level: 28 ft.
Surface material seems to fill hollows in an uneven bedrock surface.

T=55°F C=1550 µmohs/m

Send report: Mr. (*name removed for privacy*), Marwayne

One other well dug with shallow bedrock:

Sketch – stop 177

178 Water wells

(a) Depth: 11 ft Water level: 7 ft.
Water from sand. Suitable for domestic supply. Can pump dry.

T=50°F C=950 µmohs/m

(b) Depth: 11 ft Water level: 5 ft. (stat)

T=45.5°F C=1650 µmohs/m

Owner reports very varying conditions encountered with digging for water. Within a farm yard, at short distances holes will encounter gravel, sand, and clay, making the search a very uncertain activity.
Similar comments passed by **177**.
From and through the yard runoff channel goes. It is lined with phreatophytes. The bottom is set, mossy.
In winter ice builds up. Presently water table in dry hole is at surface.
This is one of those channels described at **175**. Comments made there, regarding the shortness and shallowness of systems, associated with the sandy but discontinuous till (surface) material, resulting in a rapidly alternating discharge-recharge features pattern, seems to be corroborated.

179 Floodplain – valley flank – Vermillion River

Broad, flat bottomed floodplain flanked by steep banks. Floodplain is farmed, wheat, oats. Good, even growth. Gnarly, dry, aspen growth uniformly covering steep flanks.
All these features indicate lack of intensive, perceptible discharge, that would have an influence on the physical appearance of the country side.

In the Lea Park shale area no differentiated development in recharge-discharge areas, except due to short local systems in sandy environments, hills.

180 Farm well

Depth: 252 ft. Water at; 100 ft. from surface.
Sandy at bottom. Never been pumped dry. Tested at 10 gpm.

T=47°F C=1200 µmohs/m

181 Farm well

(*name and address removed for privacy*) Marwayne
(a)

TDS:	1096
Ign. Loss:	120
Hard:	400
SO4:	339
Cl:	62
Alk:	540 (bicarb. lime, magn, soda)
Nitrite IV:	nil
Nitrate IV:	nil
Fe:	0.06

T=53°F C=1480 µmohs/m

(b) Dry well
Water

T=48°F C=5500 µmohs/m

Two wells:
(a) in use – house

0	-	1	Topsoil
1	-	10	brown clay
10	-	15	brown till
15	-	18	gravel
18	-	21	grey till
21	-	22	gravel
22	-	38	grey till
38	-	39	cemented gravel
39	-	90	grey till
90	-	100	grey till – gravel lenses
100	-	135	grey till & fine gravel

Water level: 108 ft.; tested at 11 gpm for 24 hrs; E-log shows porous zone from 108 to 125.

(b) abandoned, insufficient

	-	to 105	same as above
105	-	120	sand, fine gravel
120	-	121	boulder
121	-	210	grey till with gravel lenses
210	-	240	gravel & sand
240	-	245	grey till
246	-	267	grey till
267	-	273	gravel

Tested at 2 gpm for 24 hrs.; Water level: 186.

182 Spring

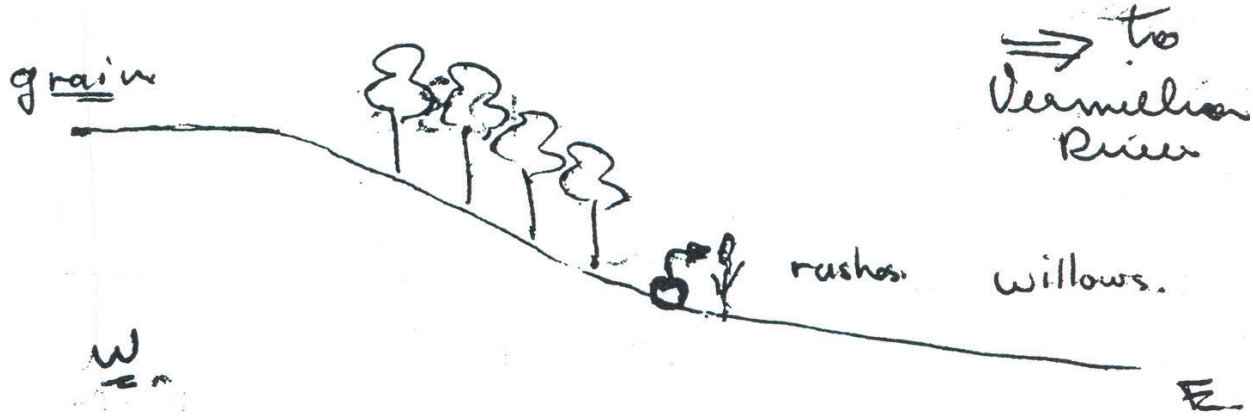
Discharge: 9 gpm (measured by farmer)
Spring is surrounded by clumps of willows, and Balsam poplar. Poplar and willows reach considerable size. Underbrush is lush and abundant. Nettles are very common. Grass in the area is approx. 3 to 4 ft. high.
Iron content is obviously high since the area over which water flows is completely covered with iron deposits.
Spring is situated on north side of an east-west running ravine.

T=43°F C=1230 µmohs/m

Surface is part of larger (~100 x 100 ft.) seepage area.
Surface cover in the area is till.
Note: Poplar (Balsam predominantly) are healthy and of good size.
Water from **182** runs overland for approx. ¼ mile, then goes underground again. Vegetation at this point is as lush and abundant as at spring.

Photo
Photo: of east bank of Vermillion River. Clumps of poplar indicating spring sites. Taken from site **182**.

182(a) Active seepage
~150 to 200 yards north of **182**, situated at base of hill:



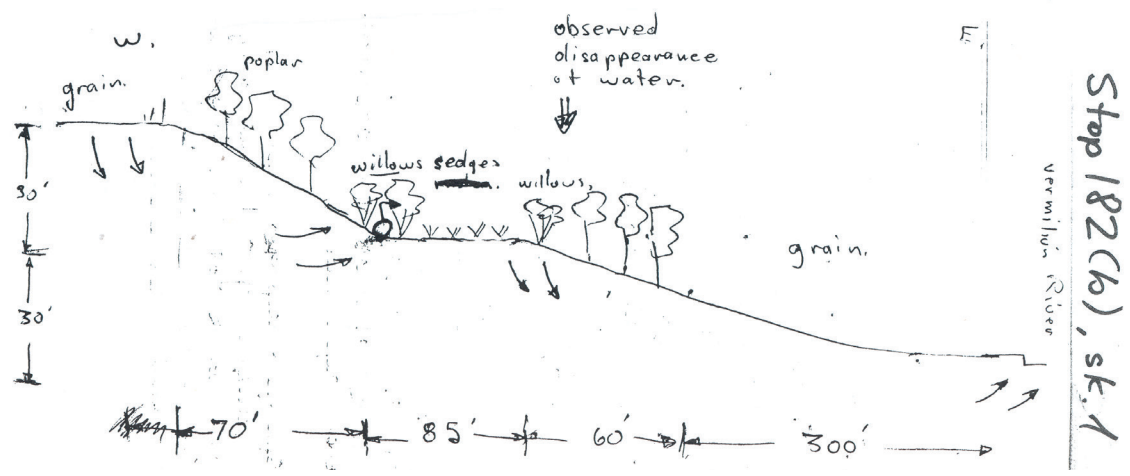
Sketch – stop 182(a)

Tree growth as per **182**. Rushes are very pronounced in an oval area immediately below discharge point. Water has same rusty appearance as **182**.

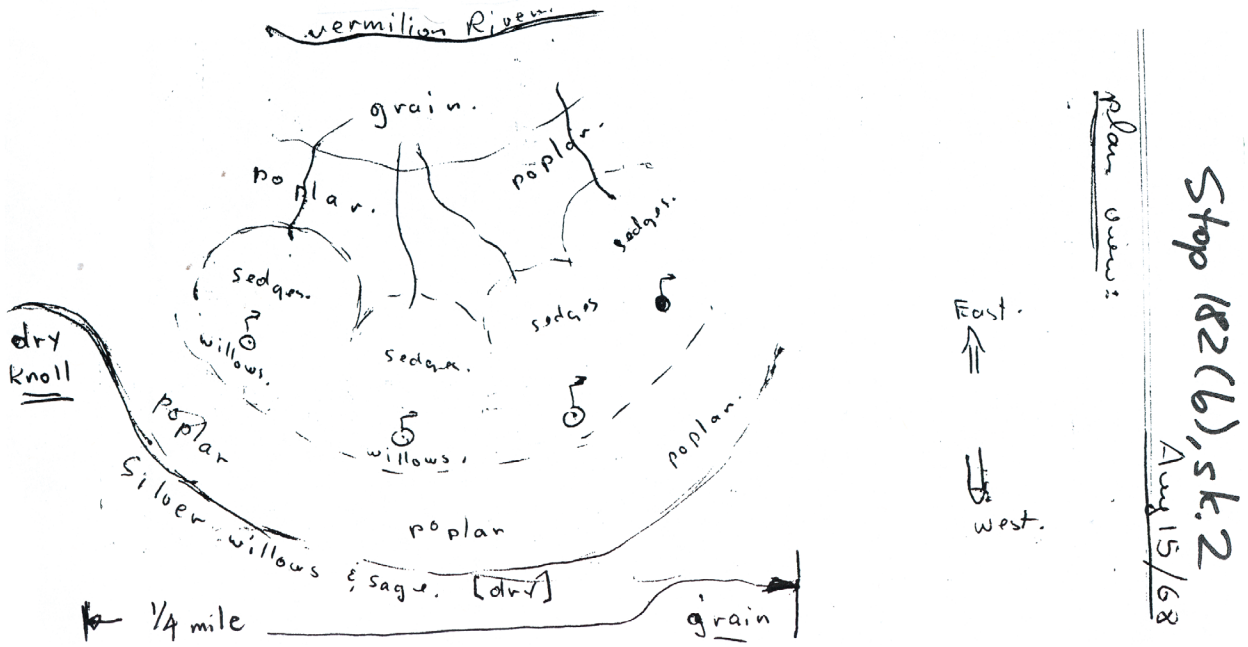
182(b) Spring
~80 yards, north of **182(a)**
182(a) and **182(b)** separated by marshy ground.
-discharging 3 to 5 gpm
-otherwise same as **182** and **182(a)**
-appears at break in slope as **182(a)**

T=41°F C=950 µmohs/m

Note:
Springs and seepages build terraces of iron rich ooze rather than depressions.
Springs and seepages reported for a distance of ~1 ½ miles along river bank at same elevations. Also on opposite side of river as shown by photo.



Sketch – stop 182(b), sk.1



Sketch – stop 182(b), sk 2

Note:
Despite presence of abundant discharge, no spruces are present.

Water well of house of **182**
(*name removed for privacy*), Marwayne
Drilled (rotary); Water level: 35 ft. (approx. level of springs)

0	-	1	boulder
1	-	14	sandy brown till
14	-	18	brown till
18	-	19	gravel
19	-	76	blue till
76	-	81.5	grey sand }water
81.5	-		blue till

Tested at 10 gpm for 1 ½ hrs.
Drawdown: 5 ft. in 1 ½ hrs.

TDS:	728
Ign:	250
Hd:	510
Sulph:	27
Cl:	15
Alk:	675 (HCO3 of lime, magn, soda)
Nitrite IV:	0
Nitrate IV:	0
Iron:	4.6

Friday, August 16, 1968

Lv. Vermillion: 7:15 AM 3201 mi.

183 Valley bottom – flanks

Broad, gently rolling flanks of Vermillion River. South facing slope is bald pasture grass, with the exception of few clumps of dry aspen and aspen and willow in well developed runoff coulees. North facing slopes are densely wooded with uniform, medium well developed aspen. Base of valley and lower slopes on north side (area of detailed investigation) are dry – no distinguishable discharge features observed.

Between 183 and first road to north conditions do not change. Environment appears dry. On flat hill tops, in local depressions standing water, probably from rain:

T=55°F C=610 µmohs/m

No differentiation between recharge and discharge area appearances: low rates of flow

184 Water well

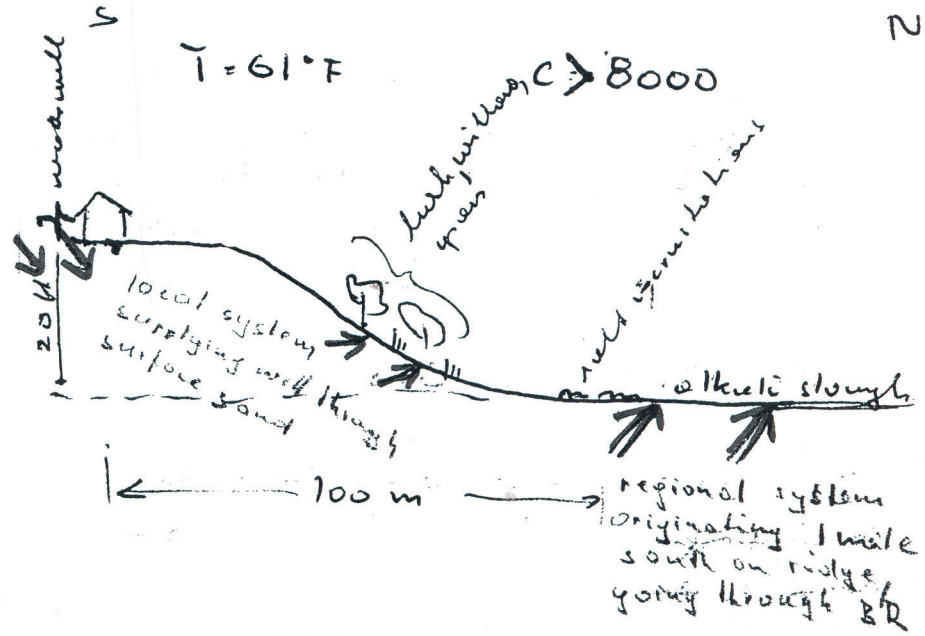
Approx. depth: 22 ft.
Water probably from sand. (From pressure system)

T=58°F C=700 µmohs/m

Gently rolling country. Well is near depression, but above alkali slough by approx. ____ft.

Alkali slough

Very shallow (20-25 cm at center) sandy, bentonitic clay, flat, with water. Water is receding fast leaving heavy white salt incrustations around rim of lake.



Sketch – stop 184

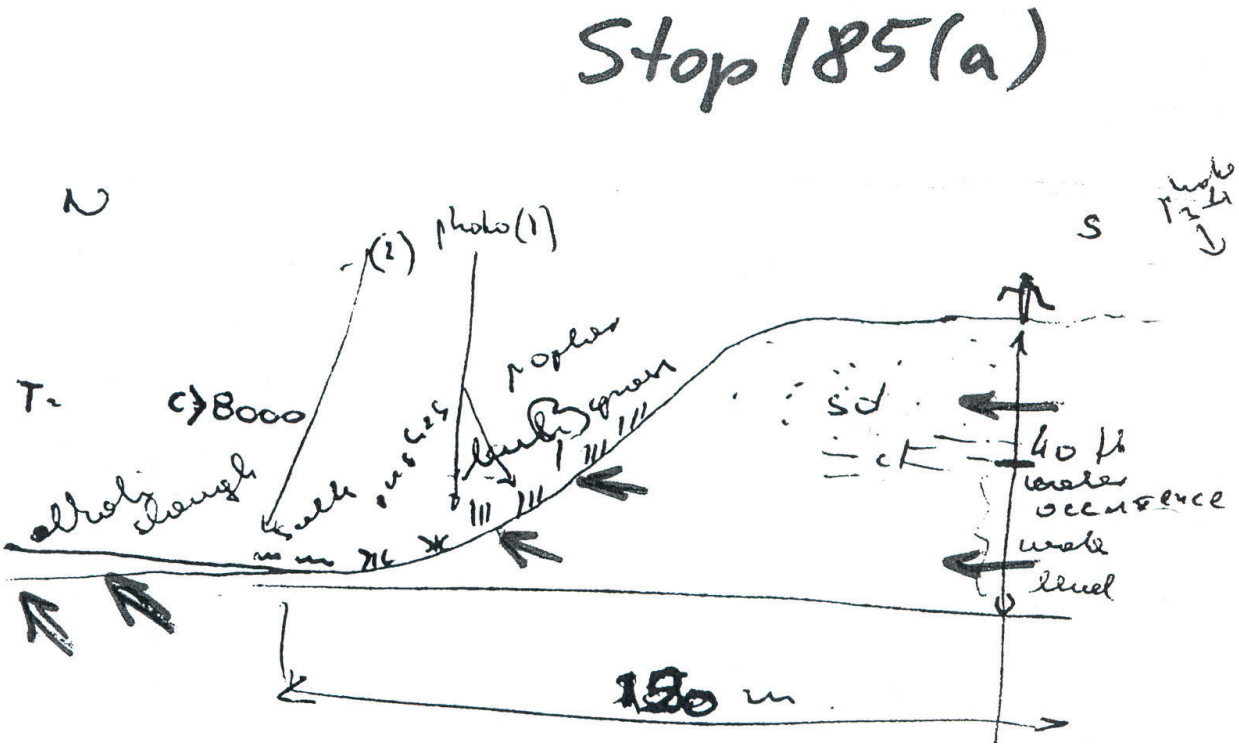
185 Water wells
(Sample 185)
Cattle well

T=41°F C=530 µmohs/m Q~3 gpm

3 wells. Depths 100 ft.; Water level: 40 – 60 ft.
Water from loose sand, with clay partitions

Formerly, water used to be obtained from dug wells less than 25 ft. deep. In present wells, water comes in all the way down from 20 ft.

185(a) Alkali slough
(Sample 185a)
Large slough with perennial water in it. Presently water level is slightly below normal. Heavy alkali incrustations surround lake like white rim. Lake level is approx. 40 ft. below well tested above. There is a drop between well and slough, with conspicuously lush grass, poplar, and willow vegetation.
Situation is identical to that described at **184**.



Sketch – stop 185(a)

Photos
Photos: (1) knee deep or deeper, lush grass vegetation with medium well developed poplars in background (local discharge)

(2) alkali slough shore (regional discharge)

Home well C=530 µmohs/m
Barn well C=580 µmohs/m

Photos
Photos (3-4): Recharge area (sage, silver willow on hill top) of above local (and perhaps regional) systems.

Photos
Photos (3) (for different exposure times): Silvery hillside: ground mat plants in foreground; sage in middle; silver berries in background.

Note:
The amount of specific difference (difference per unit of area) between the physical appearance of recharge area and discharge area of a flow system is a function, and directly proportional to the intensity of the water circulation (flow systems).
The total amount of difference (specific difference x area) is proportional to the total amount of water circulating.
Examples:

(1) large differences over small, restricted area: intensive, small, local systems.

(2) Large differences over large area: intensive, broad, regional systems

(3) No difference: sluggish systems.

186 Vermillion Valley – Hill – Alkali slough

Little if any difference observed across the valley wall, down to the water's edge. On the flat, horizontal floodplain sedge grows on hard, dry ground: surface water.

Top of hill – same

North side of hill: alkali slough.

187 Alkali flat

Extensive, gently sloping flat at the base of major rise. Some patches of salt incrustations with purple salicornia rubra. On upslope part willow and poplar, aspen growth.
In ditches drying juncus. In four-foot hole dry, no water found, but soil moisture noticeably increased in the pebbly (?) till material to almost sensible saturation. In till very large amounts of weathered minerals, mica pyrite etc.

188 Runoff Channel

Narrow, permanent channel, without valley, approx. 2 ft. deep, meanders across above mentioned flat. Water in channel does not appear to be flowing.

T=59°F C=1620 µmohs/m

Associated vegetation: drying phreatophytic grasses, juncus, sedges, only along channel.

189 Water well

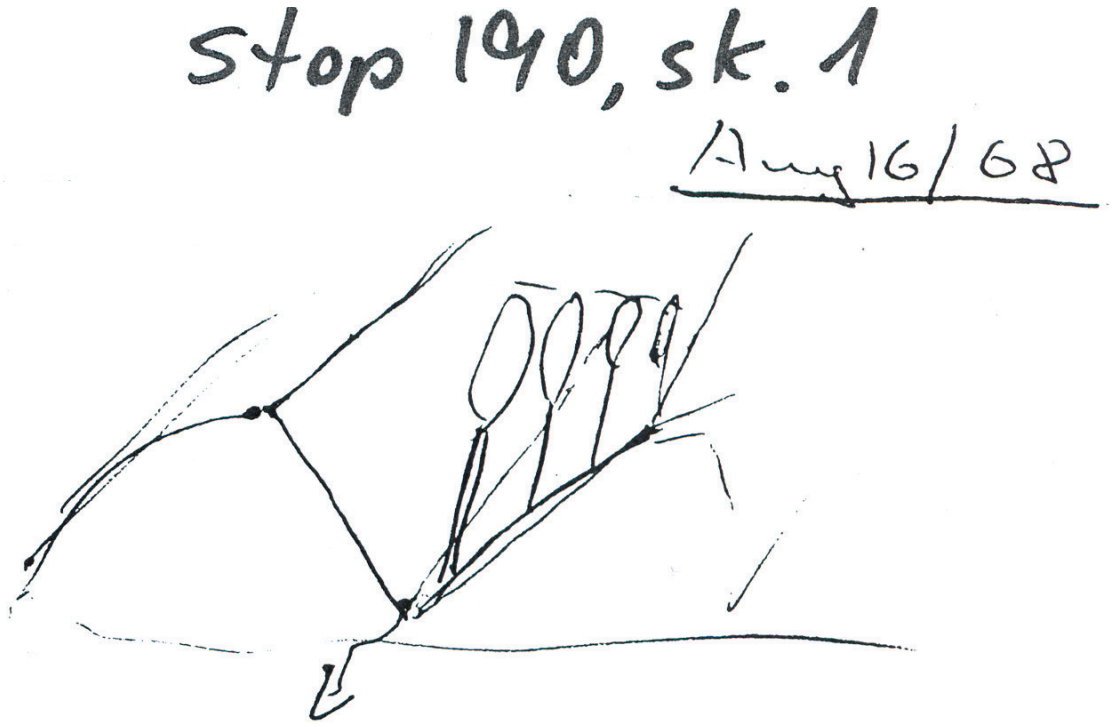
(*name removed for privacy*), former owner, knows well depth:

T=52.5°F C=2200 µmohs/m

190 Spring

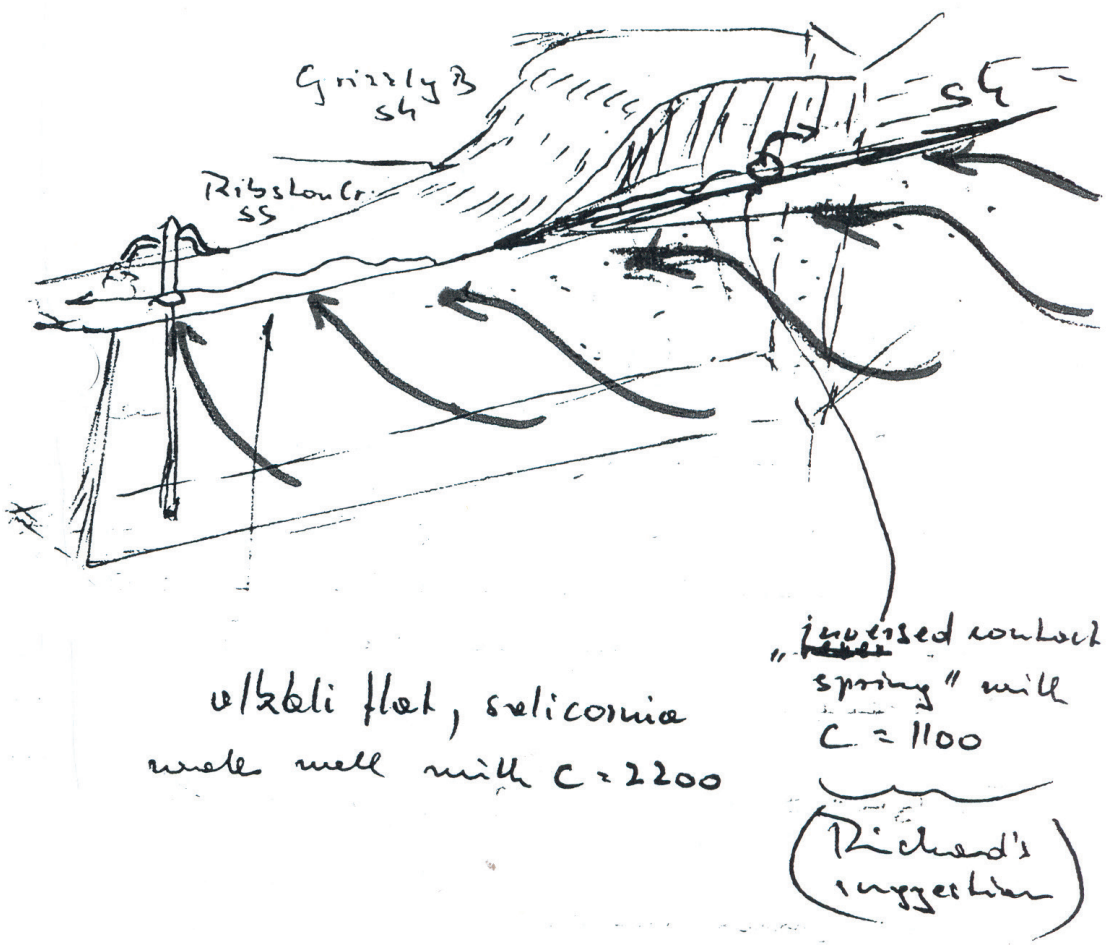
T=55°F C=1100 µmohs/m Q=?

Owner reports various springs "along the valley", which is the west embankment of the valley, closely coinciding with the Ribstone Creek sandstone – Grizzly Bear shale.
Spring water widely meanders over the plain, crossing road at **188** (8-17-51-9W4).
At **190** it crosses farm road through a culvert, at approx. 4-5 gpm. Yellowish slimy deposits indicate sulphur. Water is coming down in coulee with heavy phreatophytic growth. This type of vegetation is similar to **182** and is common on the west side of this valley, probably indicating more springs.
In this area the following discharge features are associated: alkali, phreatophytes, gumbo soil, springs.
Also, on N side of spring discharge channel, which is a deeply incised valley in the embankment, excellent example is found for the "tree size varying as a function of groundwater supply": on the high banks poplar stands as high as in the valley bottom:



Sketch – stop 190, sk. 1

Note increase in conductivity between spring & house well; both waters may have the same origin.



Sketch – stop 190, sk. 2

Photos
Photos (3): (1) intense seep, indicated by lush growth of sedge on side hill (view uphill – west)
(2-3) seeps, view NE. Slope, of side hill, phreatophytes on both sides of road, wet soil (in foreground) alkali & salicornia – not seen in background, farther down slope.
Outcropping rock is sandstone above seep!

191 Water wells (2)

Depth: 70 ft. Water level: 67 ft.
Enough for house, other for stock but it is easy to run it dry (1 gpm)
There are springs in every quarter. Just small seepages which run dry occasionally, particularly in the late fall.

T=55°F C=1200 µmohs/m Q=1 gpm

Sulphur smell.
Also there are "soap holes" everywhere in the district causing trouble for cattle. "It kinda seals them"
Seeps reported ¼ mi. NW; ½ SW.
These soap holes and seeps are associated with alkali.

Saturday, August 17, 1968
Lv. Vermillion: 8:00 AM 3280 mi.

192 Extensive active seepage
Starting at the base of a slight (2 m) embankment area of extensive (at least 200 x 100) active seep occurs on side hill. Area is boggy, marshy, with open water standing, and locally perceptibly moving in abrupt edged depressions between small (2 x 2 ft.) clumps of rushes.
Water bodies have whitish, creamy "sulphurous" muck layer sediment on sandy bottom. Large number of snails. Locally, pinkish sediment, suggestive of sulphur springs and seeps described in Northern Alberta. Area is characterized by lush poplar and aspen growth, alder, rushes and sedges. Seepage is developed in or on Ribstone Creek sandstone, found in outcrop in road cut just uphill of site.

Stop 192

Photos
Photos: (1) General view of part of seepage area, view to east.
(2) General view of part of seepage area, view to west (downslope) showing large extent, general type, boggy nature, poplar growth, juncus vegetation etc.
(3) Slimy mucky depression
(4) Pink muck, snails, creamy slime.
(several double photos to ensure correct exposure time)

Sulphur odor noticed. Mosses.

T=55°F C=1150 µmohs/m

Evidence for : “degree in feature differentiation – proportional to flow intensity”. Sandstone; high intensity: should be good supply.
(Muck sample)
Approx. 200 m down slope from head of seeps slight but definite efflorescence of alkali, associated with purple patches of salicornia. All this in very sandy soil.
Road is sandy, and is wet on both sides at the active seeps.

Photo
Photo: Characteristic appearance of seepage associated vegetation in the Belly River (Ribstone Member) environment in East Central Alberta. Dark patches of salicornia, slightly alkali pasture, sandy road in right foreground; willow, poplar at previously described seeps in background and cattails, tall sedges in left foreground.

193 Water well
Depth: 150 ft; Water level: 45 ft.
Drilled for storage because it does not come in fast enough. Water is from “rock”. Close to bottom coal.

T=44°F C=1040 µmohs/m Q<2 gpm

“The whole valley is a muskeg”, which statement confirms the general indication of the trees, vegetation, etc.

194 General Observation
Poorly developed aspen, no poplar, short grass, generally dry conditions. High degree of difference in appearance between **192** and **194.**

195 Water well
Depth: shallow; Water level: 12.5
Water at: ?; Form.: sand

T=44°F C=1020 µmohs/m Q~can’t pump dry

General area between **194** to **195** is hilly, with numerous depressions of varying size. They seem to be of intermittent nature, as indicated by the thin belt of phreatophytic vegetation and abrupt change of moisture conditions around them. Recharge sloughs. Area is noticeably dryer than at **192**, with dense, crooked stunted aspen stands, short grass etc. on hill tops; and small, very definitely defined (sharp boundaries) relatively moist areas in depressions. These depressions may intersect the water table: some of them do not dry up in the fall.

196 Water well
Depth>70 ft. Water level~65
Water at? Form: clay
“they struck a little bit of sand but it was only a few inches.” Poor supply.

T=46°F C=1100 µmohs/m Q<1 gpm
(in Grizzly Bear shale)

197 Water well

Depth: 17 ft. Water level~?
Plenty of water: it is actually a spring and is in line with a second well of owner of **196**, having the same properties.

T=42°F C=960 µmohs/m Q=good

Both **197** and lower well of **196**'s owner are located under an escarpment, probably associated with the out or subcrop of the Grizzly Bear shale. The same escarpment was observed at **193**, and previously at other localities.

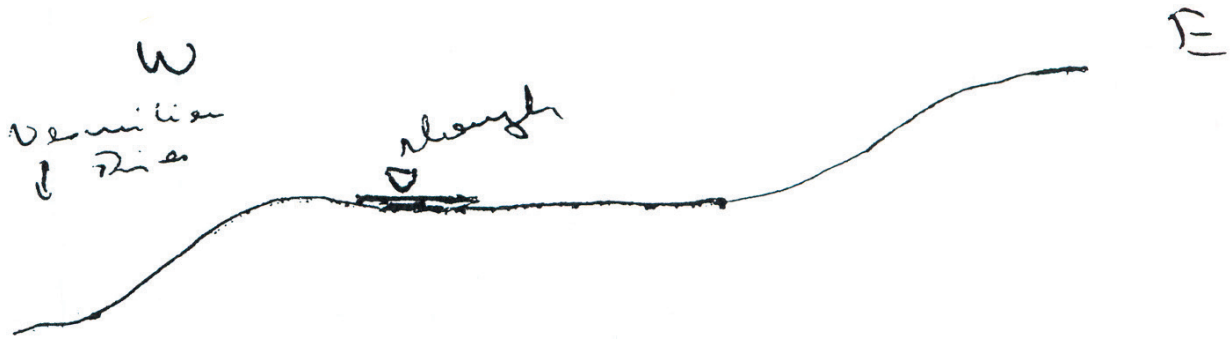
197 is located in a large (40 m in diameter), circular depression with an outlet runoff channel.

198 Permanent slough

(in really dry years: dry)
Surrounded by well developed aspen and poplar belt, cattails etc. Seems to mark contact between Grizzly Bear shale and Ribstone Creek sandstone.

T=63°F C=300 µmohs/m

The slough itself is located on the edge of a flat portion of the valley; 4 ft. deep.



Sketch – stop 198

199 Water well

Depth: 65 ft. Water level: 35 ft.
Good supply

T=42°F C=1300 µmohs/m (coaly)

No seeps or springs known by owner.

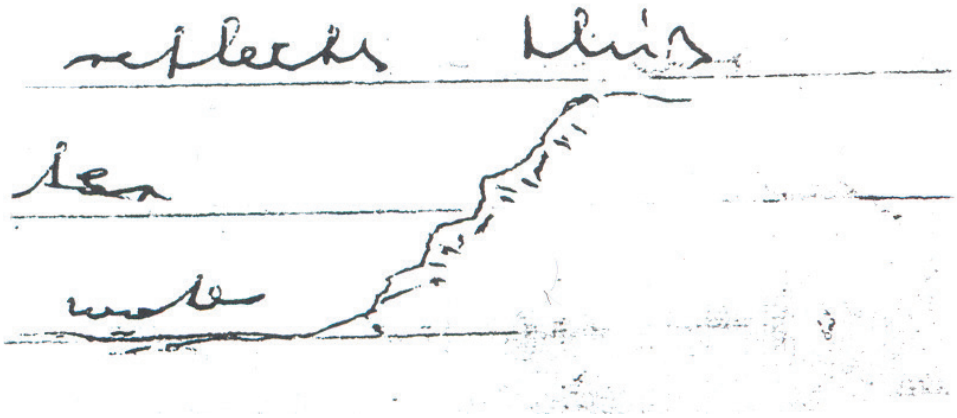
Various Short Field Trips: Central and Southern Alberta

Section B
Field Notes

By Dr. József Tóth
May 1964 to August 1969

May 1, 1964

1 Highway excavation pit
A dugout of approx. 50 x 40 m and 6 m deep. Bottom contains open water.
Top formation is highly oxidized till, to a depth of about 2 m. Below the till reworked bedrock. The bedrock is bentonitic evidenced by intensive sun (mud) cracking on the surfaces of the pit-walls. At places the surface is covered by very heavy salt precipitates. Below these areas the soil is moist to saturation. Parts of the relatively undisturbed bedrock are oxidized. Bedrock consists mostly of dark (wet) shale with sandy bands. At these bands salt precipitates are heavier. Erosional surface reflects this banded character.



Sketch – stop 1, 1964.05.01

Hole of about 5' x 2' was dug under the open water with the geological hammer. Whereas the sandstone looked relatively porous no water could seep into the hole because the pores are plugged by bentonite.

Photo
Photo: of the saline walls of the pit.

This area is flat. It is the Northward Extension of the Torlea flats and is noted for the high water levels. This is expected on theoretical grounds but the deep level of water in the dugout seems to contradict or at least to be an exception. The low level is explained by a relatively low rate of discharge due to the low permeability as compared to the rate of evaporation.

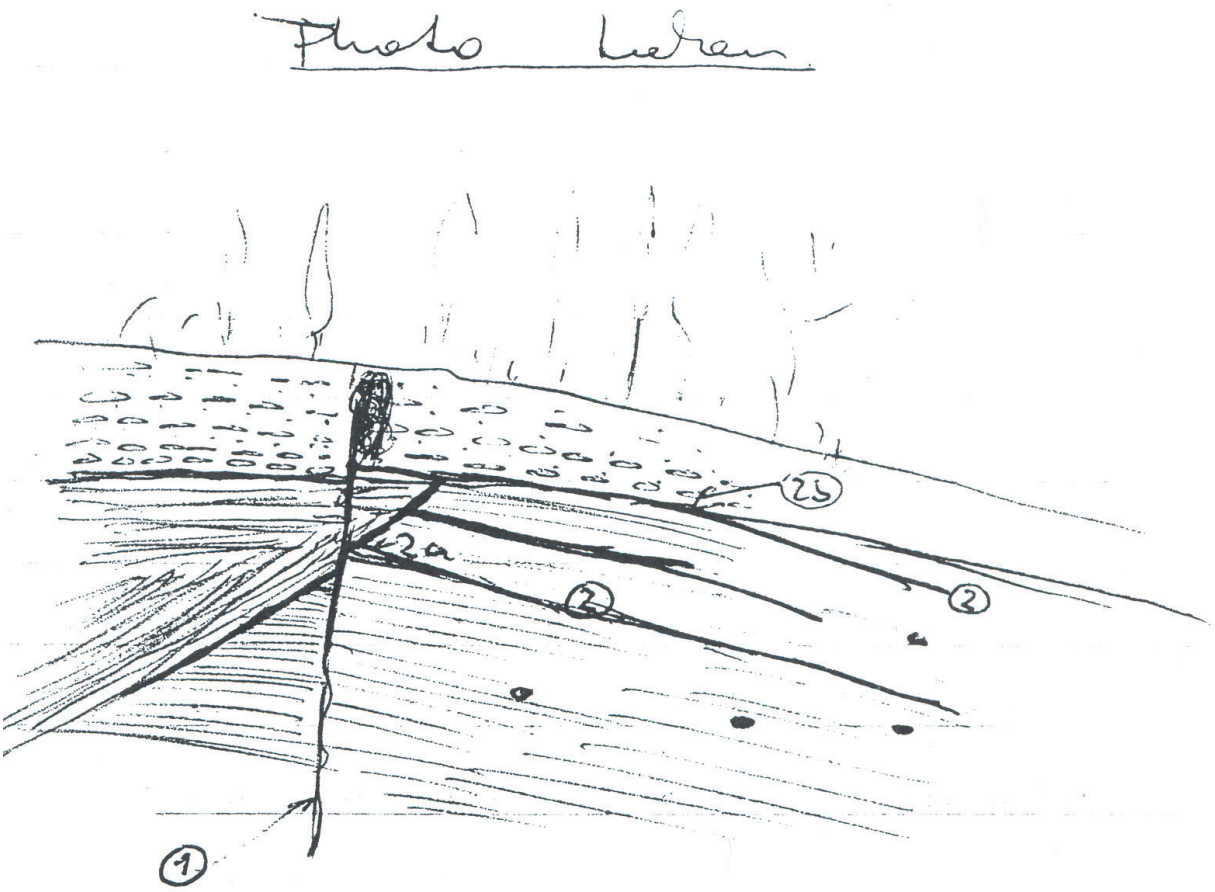
2 Road Cut
Exposure of lacustrine sands and fluvio-glacial gravels.

Sand: fine to medium light brown unconsolidated. Laminated cross bedded. This sand is overlain along a very even straight surface by
Gravel: granular to pebble thin bedded, unconsolidated, well sorted, directed deposition.

Some recent slumping is apparent. Small faults are observed cutting across both the sands & gravels. White precipitates mark the paths of intensified / concentrated seepage of groundwater. These paths follow surfaces of discontinuity. Four such surface-types are readily distinguishable:

1. Fractures
2. Planes of lamination
3. Boundaries of cross-bedding
4. Along roots of plants

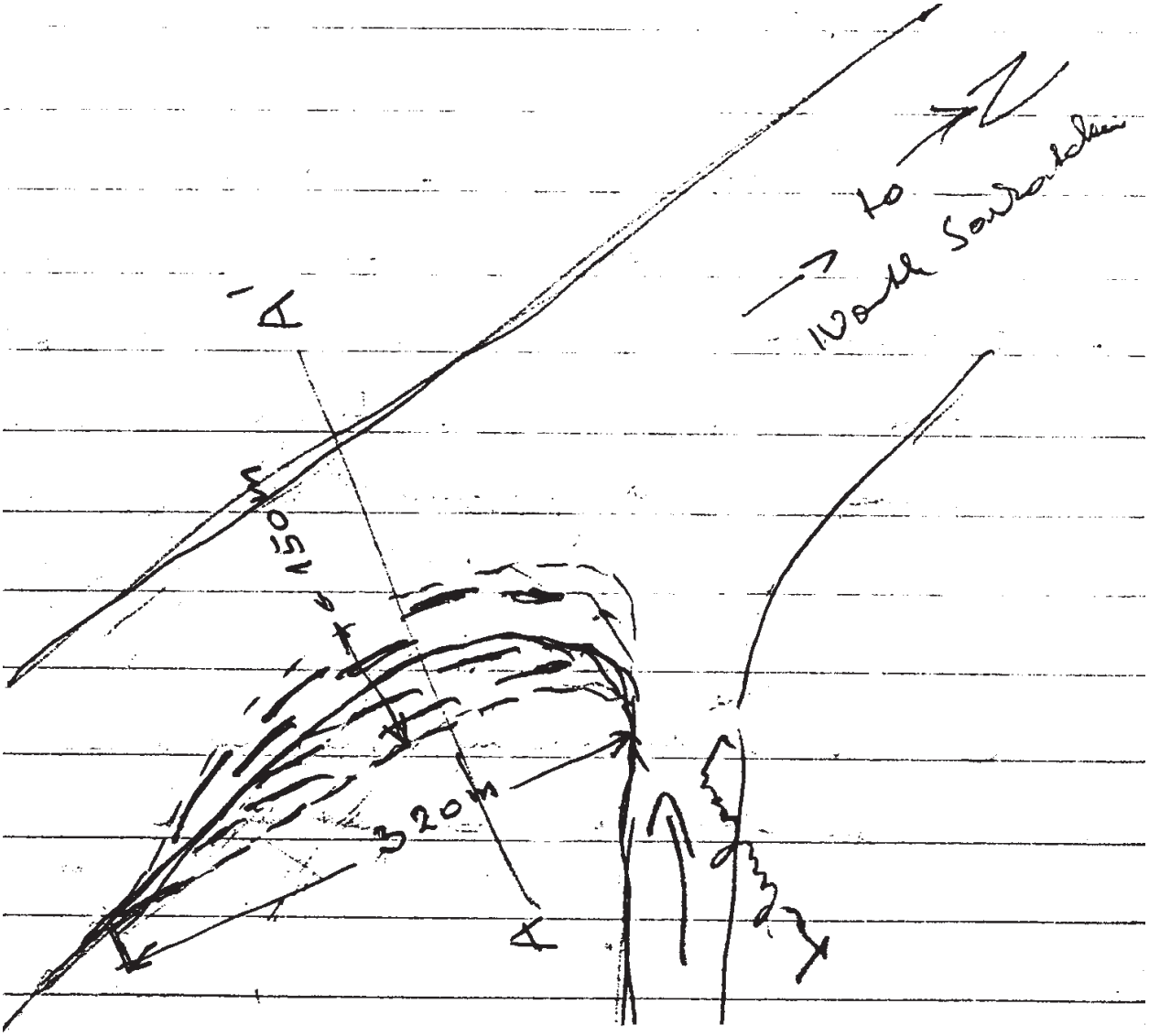
Photo
Photo taken:



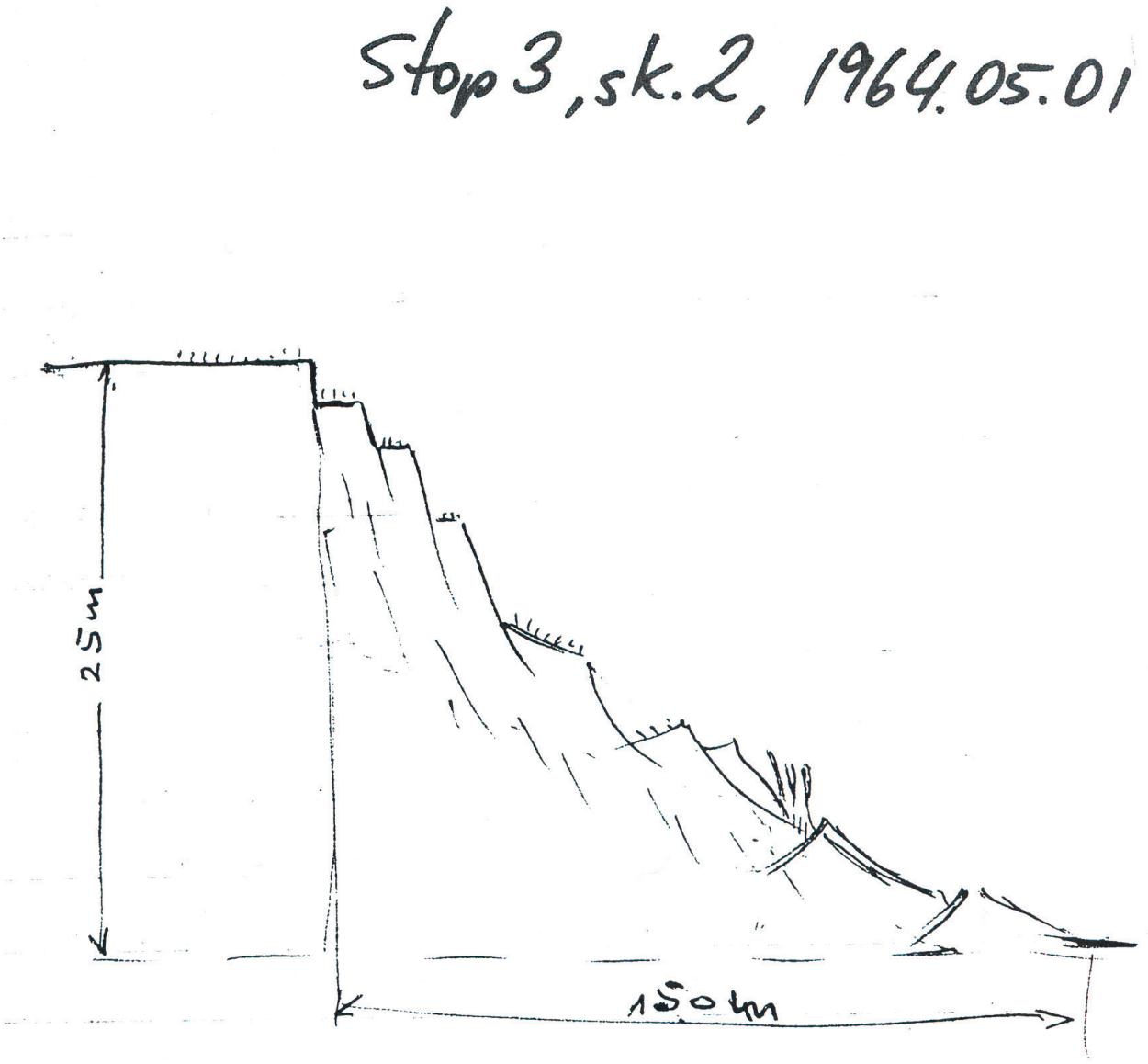
Sketch – stop 2, 1964.05.01

Photo legend:
1. Fractures might go (as in the sketch) through the gravels. The solutions give better induration to the unconsolidated gravels and they will stand as a slightly protruding column along the fracture.
2. These planes receive their water from other planes of discontinuity, such as fractures (2a) or contact between the sand and gravel (2b).
3. Also the cross-bedding planes water originates at other discontinuities.
4. White salts precipitate around roots forming tabular bodies of about 1/2” in diameter and hollow on inside (sample).

3 Recent Landslide
Reported by (*name removed for privacy*)
Occurred: April 1963
Location: NE-8-55-8W4
6 mi. NE of Myrnam



Sketch – stop 3, sk.1, 1964.05.01



Sketch – stop 3, sk 2, 1964.05.01

At the bottom of the slide autochthon breccia of fine siltstone. At one place water is noticed to seep out of the ground.

Photos

Photos: On slid-down parts stubble is still standing. Fractures parallel to creek-bed-strike.

September 4, 1964

Groundwater Field Trip

White bentonitic sandstone lens in the Edmonton formation, East of Drumheller on Hwy 9, East side of the road.

"Tiny Chapel", size 7 x 11 x 12 ft. with a 17 ft. steeple. Seats 10,000, six at a time. (*removed*) with 3 min. sermons for several faiths and hymns. Built in 1958. Tiny Chapel is at the head of the 35 mi. Dinosaur Trail, at Drumheller.

Glacial channel on Aspen Parkland region approx. 12 mi. north of Trochu, on Hwy 21, looking north (and a bit of landscape).

Below is an English translation of the original field notes, which were in Hungarian. The original text appears on the following page.

April 30, 1965 (Sunday)

Beaverhill Lake

Sunny, partially cloudy, around 8 degrees C, cumulus clouds.

1. Shallow in northwestern part of lake. When we arrived a huge amount of geese on the shallow part of the lake. Granary approximately 100 metres from water. We are waiting under cover close to the granary. After approximately 30 minutes of waiting, the geese are beginning to return, firstly they landed on the shallow water about 400 metres away from us. Later on they are closer to us.

   During this most of the ducks stayed in place. Approximately 250 metres from us, three *Branta Canadensis* stayed in the same spot, consistently observing the approaching people and dog.

   Shallow water is blackened by so many waterfowl.
   Great majority of geese are resting here during migration.
   Most of the geese are *Branta Canadensis* with *Anser Albifrons* mixing in with them. Four *Chen Hyperborean* (snow goose) are landing on the water as well.

   The majority of ducks are *Anas Platyrinchos* and *Anas Acuta.* We can see a few ducks submerging, we are not sure what their identity is.

   Among them are seagulls. Based on black beaks we are recognizing *Larus Philadelphia* (Bonaparte's gull); we couldn't identify white headed seagulls.

   Various wading birds (at least two species) were too far to be identified.

2. Eastern part of the lake
   The crows have returned (*Corvus Brachyrhyuchos*). They respond to crow calling but don't come within shooting range. Perhaps the barren trees do not cover us.We can see several species of predator birds but we can't identify them.
   Agrelius phoeneceus (red-winged black bird) are present in great numbers, in vegetation that is close to the pools of water, along the road and the lake.

   We saw a bird in the field and from its behavior and colour of feathers, we identified it later at home from the bird atlas as a *Shernella neglecta* (Western Meadowlark). She was scared off the poles by a car going by.

1965. ápr. 30 (vasárnap)

Beaverhill Lake

Napos változó felhözet; kb.8°C; kiterjedt, vastag hófelhök mindenhol.

1) Kiöntés a tó északnyugati végénél. Érkezéskor rengeteg liba a kiöntésen. Magtár kb. 100 m-re a viztöl. A magtar közelében meghúzódva várunk. Kb. Felóra várakozás után a libák kezdenek vissazajönni, elöszö r egy kb. 400 m-re fekvő másik kiöntésre, majd az előttünk lévőre. Ezenközben a kacsák nagyrésze helyben maradt. Kb. 250 m-re három Branta Canadensis végig helyben maradt, állandóan szemmel tartva a betolokodó embereket és kutyát.
   A kiöntés feketéllik a vizi madaraktól. A libák nagy része vonulás közben pihen itt.
   A libák zöme Branta Canadensis melyek közé igen sok Anser albifrons vegyül. Négy Chen hyperborean (snow goose) is a vizre jön.
   A kacsák túlnyomó többsége Anas platyrinchos és Anas acuta; néhány bukó kacsát is látunk, megaházásuk bizonytalan.
   A sirályok közül a Larus Philadelphia-t (Bonaparte's gull) fekete csőréröl megismerjük; a fehér fejő sirájokat azonban nem tudtuk meghatározni.
   Különböző partfutók (legalább két fajta) túl messze voltak a meghatározáshoz.
2) A tó keleti oldala
   A varjúk (Corvus brachyrhyuchos) visszajöttek. Varjúhivóra válaszolnak de lőtávalon belülre nem jönnek. Vajjon most a kopasz fák nem takarnak?
   Több fajta ragadozó madarat láttunk; meghatározás nincs.
   Agrelius phoeneceus (redwinged blackbird) nagyszámban népesiti az út és tómenti gazos pocsolyákat. Egy Shernella neglectá-t (Western meadowlark) utólag emlékezetböl, tollazatra és viselkedése alapjan itthon könyvböl határoztunk meg. 17 kerités oszlopról ijesztette el az autó.

August 10, 1965

Springs

Loc. At Wildwood Dr. -42 St. Down in river bank

Porcupine sandstone outcrop

Sandstone & shale layers interbedded. Landslides, slumping. Both sandstone & shale strongly fractured. Water is coming seeping out in streams out of fractures.

June 28, 1966

Red Deer – Roger Clissold

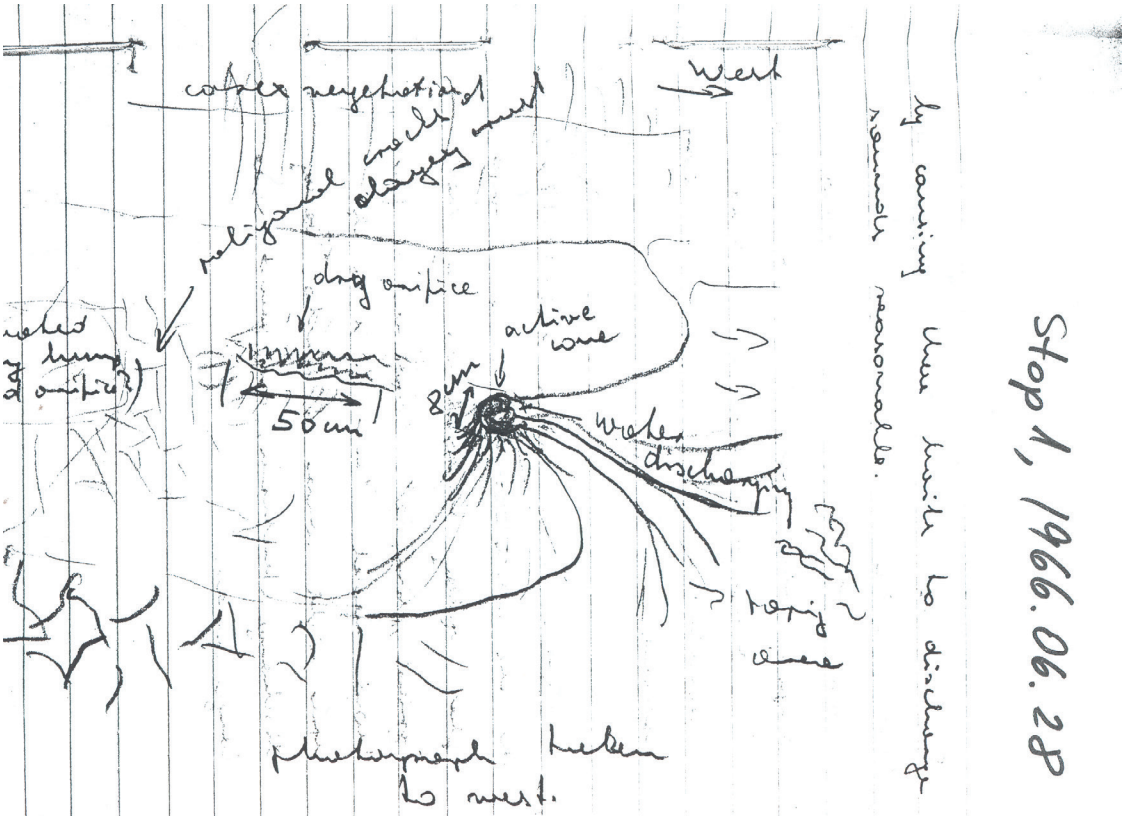
1 Soap hole (Mudbail locally)

NW-20-37-26W4

Located 1 mi. south of local divide and ½ north of creek bottom. Ditch contains open water, carex, juncus abundant; salts; surrounding area is not cultivated but used for pasture. Few hundred yards north – north east seepages, bogs, open water. Excellent spots for describing discharge features.

Photos

Fourth photo shows another soap hole with distinct ropy surface. It is discharging water at this time at several orifices. Most of these outlets (either dry or active) have a "volcano" type cone around them. One of these outlets discharges water and coarse sand; when a person stands on the cone water boils up bubbling. Roger's suggestion of atmospheric pressure changes possibly causing these boils to discharge sounds reasonable.



Sketch – stop 1, 1966.06.28

Surface of the second soap hole (or rather the area) is higher than the top of the road despite the fact that it is in the original ditch. Good indication of its "building" nature.

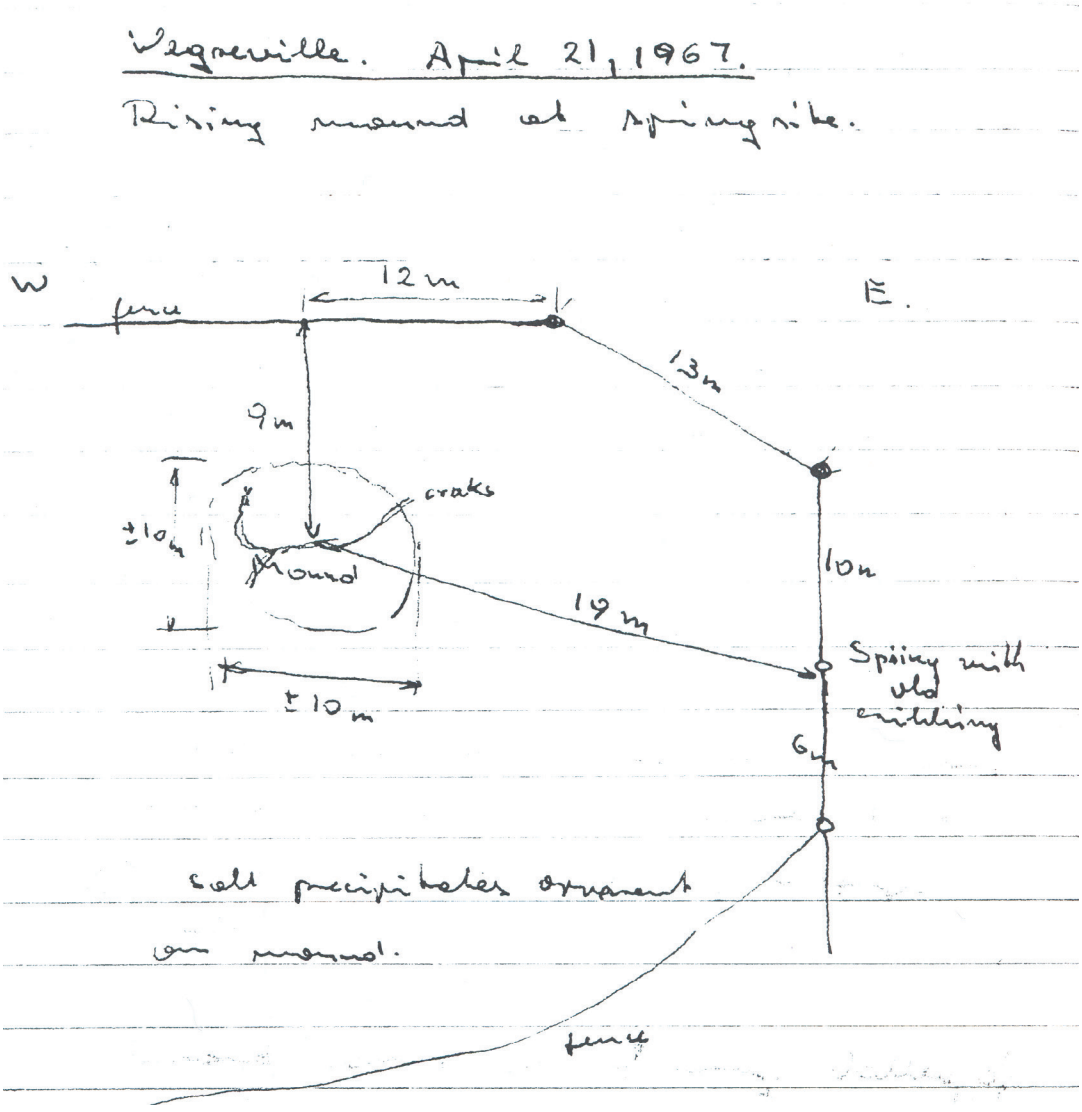
2 Photo

Photo

Photo: taken from Sec 2-37-27W4 to the Northeast showing broad flat valley surrounded by hills. Typical "simple" topography for flow model. Point **1**, is in the upper right corner of photo. In valley discharge features are found over larger areas.

April 21, 1967

Vegreville – Rising mound at spring site



Sketch – 1967.04.21

May 16, 1967

Vegreville – Rising mound at spring site

Mound has apparently largely deflated since last visit. The semi-circular crack marked with branches has partly closed up, although still clearly visible. The winter apex of the mound (marked with a long stick on present photos) has been replaced by a depression, containing water presently. This water is thought to have been derived from ice or water underneath the mound. This conclusion is based on the following observations:

1) At last visit (April 21, 1967) no snow covered the top of the mound (salt precipitate was observed).
2) At the deepest point, between the mound and the embankment, where snow was still 5 to 6 feet high in April, and from where there is no outlet channel, ground is dry now, this on the top for the mound, better exposed to evaporation, and without snow cover for the last month, water cannot be derived from other place but underground.
3) Around the mound, but mainly in the N to W quadrant (W XI N) water seems to be continuously supplied by seepage.
4) Salt precipitates are heaviest on dry parts of mound.
5) Crack around the mound is filled with water.

Water is observed to move overland from the "apex depression" towards the old cribbing to the NE, and from there into the large body of open water to the south.

A shallow (few inches) channel to the SE leads out of the apex depression into the open water area. The bottom of this channel is noticeably moister than its banks, due to seepage water. (Four photos of mound)

Photos

Photograph: taken 50 m W of N-S road on Mr. (*name removed for privacy*) side hill towards Vermillion River. It shows heavy alkali precipitates on side hill; associated with seepages and soap holes. Carex not seen in picture but observed with actual discharge of water today. Willows of rising mound should be in upper left corner of picture.

June 21, 1967

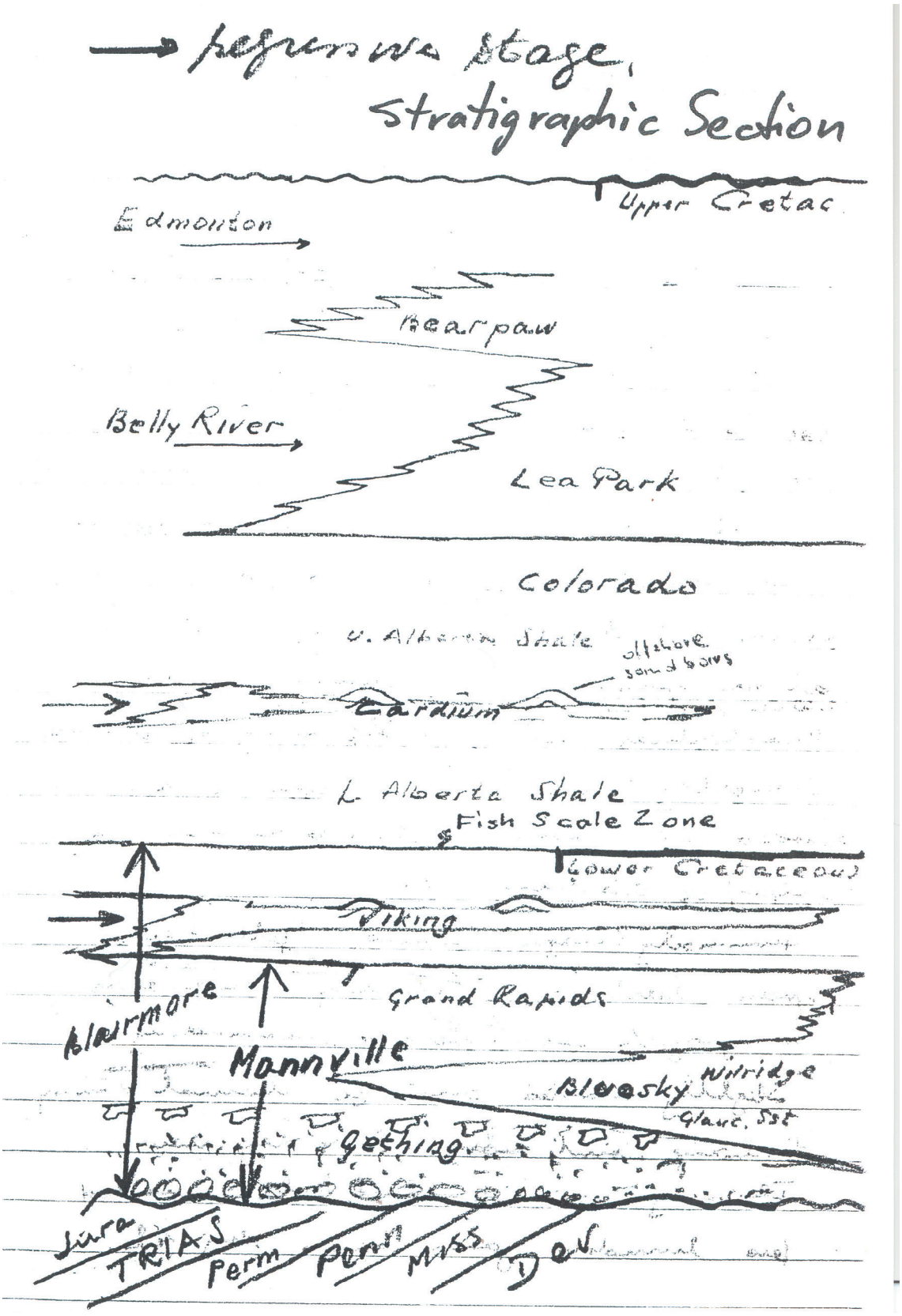
Devon Slide

½ mi. south of Hwy bridge, on slope on south side of road.

Water issuing at approx. ½ gpm out of broken shale (**Photo**). This forms a spring line along slope and is accompanied by "bulging" (creeping) of the slope.

Photo

Photo: showing slope with some "bulge" above whitish, bentonitic sandstone outcrop**.**



Sketch – stratigraphic section

Sept. 7, 1967
Red Deer Helicopter Trip

1) Loc; SE-2-37-29 (?) Roger's point No: 431
   Seepage area on gently sloping side hill; approx. 1.5 mi. from and 270 ft. under hill top; approx. 1.5 mi. from and 120 ft above creek channel. Lush grass covers several acres of pasture land. Actual seepage at least at two points. 1" steel pipe sticking out 27 cm above ground with flowing water. (Water piped from other spring upslope)
   Slightly incised semi-circle of approx. 15 m eroded into ground uphill & around centre (pipe) of discharge.

Photo
   Hummocky (boggy) ground. Yellowish green lush grass of few hundred yards in diameter sharply contrasts to greyish green, dryer pastures surrounding it. Slightly marked drainage channel draining discharge point; channel is dry now. Flowing seismic shot holes reported few hundred yards across Hwy 42.

2) Loc; ?
   Roger's point No: 436
   Seepage area, soap holes, blister type "swamp". Patchy ground (dark, lush phreatophytic vegetation in dry environment).
   Photo

Nov. 30, 1967
Fox Creek – Water injection plant of Hudson Bay Co.
(*name removed for privacy*), person to talk to about drilling project / problems.

Dec. 1
Photos
Photo 1: Webster's only water truck on the Fox Creek project (2 rigs, many test holes, 1000 gpm requirement)
Photo 2: Water discharging from underneath snow on SW side of plant site hill. Water flows at several gallons per minute. It is probably one of various diffuse groundwater discharge points.
Photo 3: Other area of diffuse groundwater discharge. Temp. of air is about 0°F .
(Ledum groenlandicum; black spruce; cattail)

March 6, 1968

Vegreville: Breathing Soap hole
Except for deep drifts, or in deep depressions, such as the trough on the north side of the mound, snow has gone. Rise at soap hole site is very conspicuous. Estimated elevation, of apex, relative to flood water level, or which is approximately the same, level of the depression floor, is at least 4 ft. E-W diameter of risen area (from marker to marker on photo, is approx. 20 m). North-S diameter is +/- 8 m (or "18 m"?).

Mound is dry. The shallow depression channel leading from the apex to SE is clearly marked (**Photo**). Concentric extension cracks of last (1966 – 67) winter are very definite but only 1-2 cm wide. On the

south slope of the mound, at a distance of approx. 7 m from the apex fine gravel seems to cover the ground sparsely as far as the South edge of the mound. (Ground is covered with ice and water further south.)
Soap hole due East of "rising mound"
Frozen phreatophytes mark area of concentrated discharge (dog on stone is situated on it). Approx. 6 m SW (downhill) of this apex barren patches, light yellowish grey areas are found with gravel scattered on top of them.
Well defined, 50 – 30 cm wide, 10-15 cm deep channel leads from apex to the foot of this soap hole area. One long crack, in radial direction is observed running through barren patches. This area is known to be heavily alkali, and is not cultivated. Photo shows edge of cultivated area, which itself is noted for high degree of alkalization (see photo of May 16, 1967).

Seepages, soap holes
SE corner of Section adjacent to the North of previous section.
Large circular depression with obvious but now frozen spots of discharge. Perimeter of depression is well marked on photo by snow lining. Deep, valley like channel leads out of depression to the west.
Field around depression shows signs of heavy alkalization already. Depression is situated on west facing, evenly sloping hill side, approximately along the same contour where previous soap hole was. At barren patches: on depression floor gravel is scattered.
I consider depression as example of advanced soap hole development, and effect of groundwater discharge on geomorphology.

June 22, 1968

Streeter Basin - Foothills.
Walk from camp along east fork of stream.
Various springs and seepages along stream. Springs are associated with circular depressions and Porcupine sandstone outcrops. Discharge decreases upstream from over approx. 60 gpm to 2-3 gpm of the individual springs, over a distance of approx. 3000 ft.
At higher altitudes poplar (aspen) growth starts. Trees are stunted, with crooked trunks and branches in striking contrast with aspen growth observed in the Ft. McMurray and other northern areas.

Photos

Photos:
1. Stunted, low aspen growth with white (rain?) gauge, and small copper gauge in lower left corner.
2. Stunted, typical aspen growth.

West Fork of Streeter basin.
Photos

Photos:
1. view to upstream of creek. Straight flanked V notched valley indicates shaly sequences underlying stream. Flow originates upstream at spring (Stevenson's interpretation)
2. view downstream from same point. Meandering valley indicates predominantly sandstone underlying stream. Stream (spring water is influent, due to higher permeability.

Photos intend to show actual situation of stream becoming influent from effluent; pictures taken at point of change of conditions.

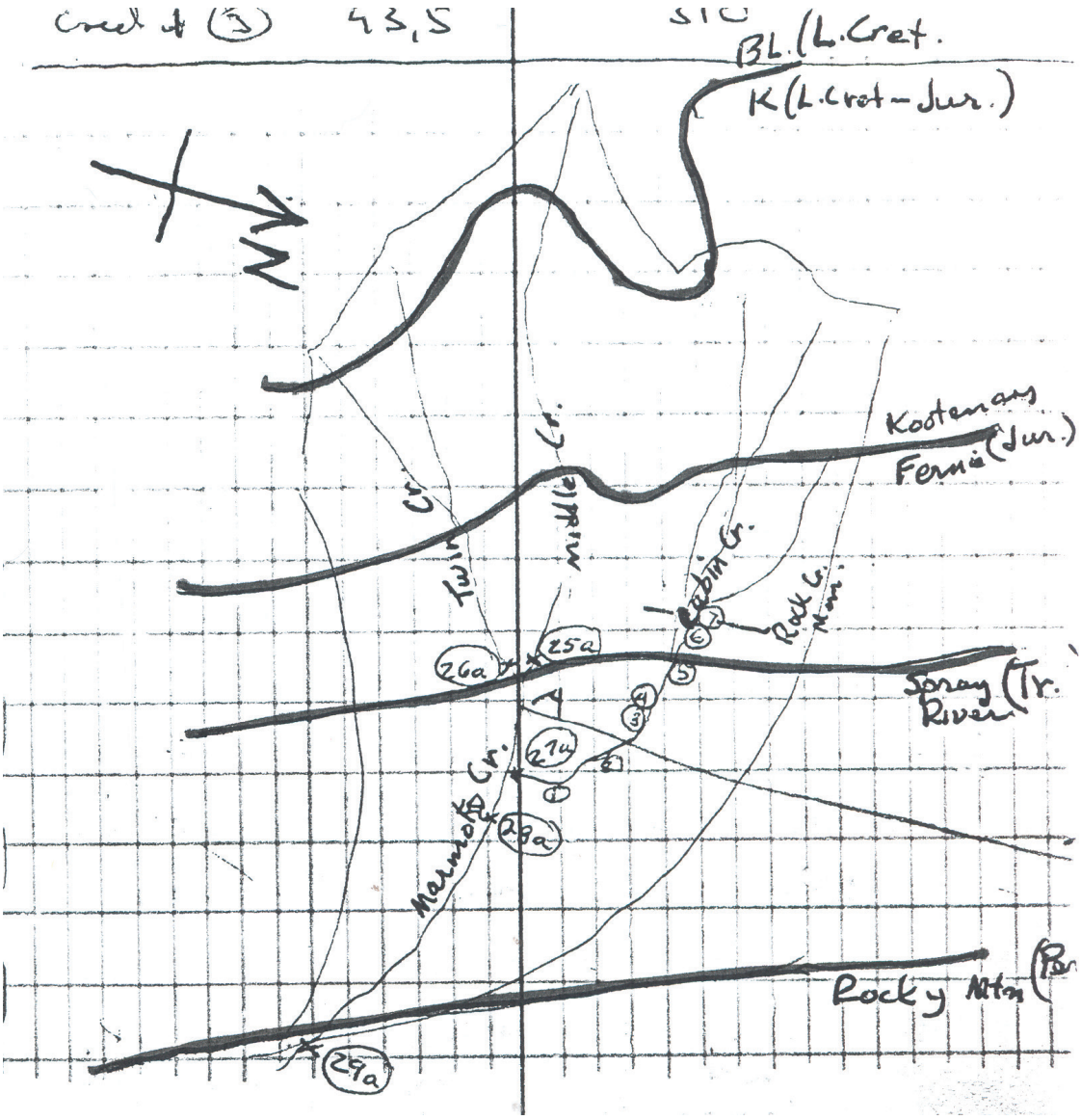
June 24, 1968

Marmot Cree basin

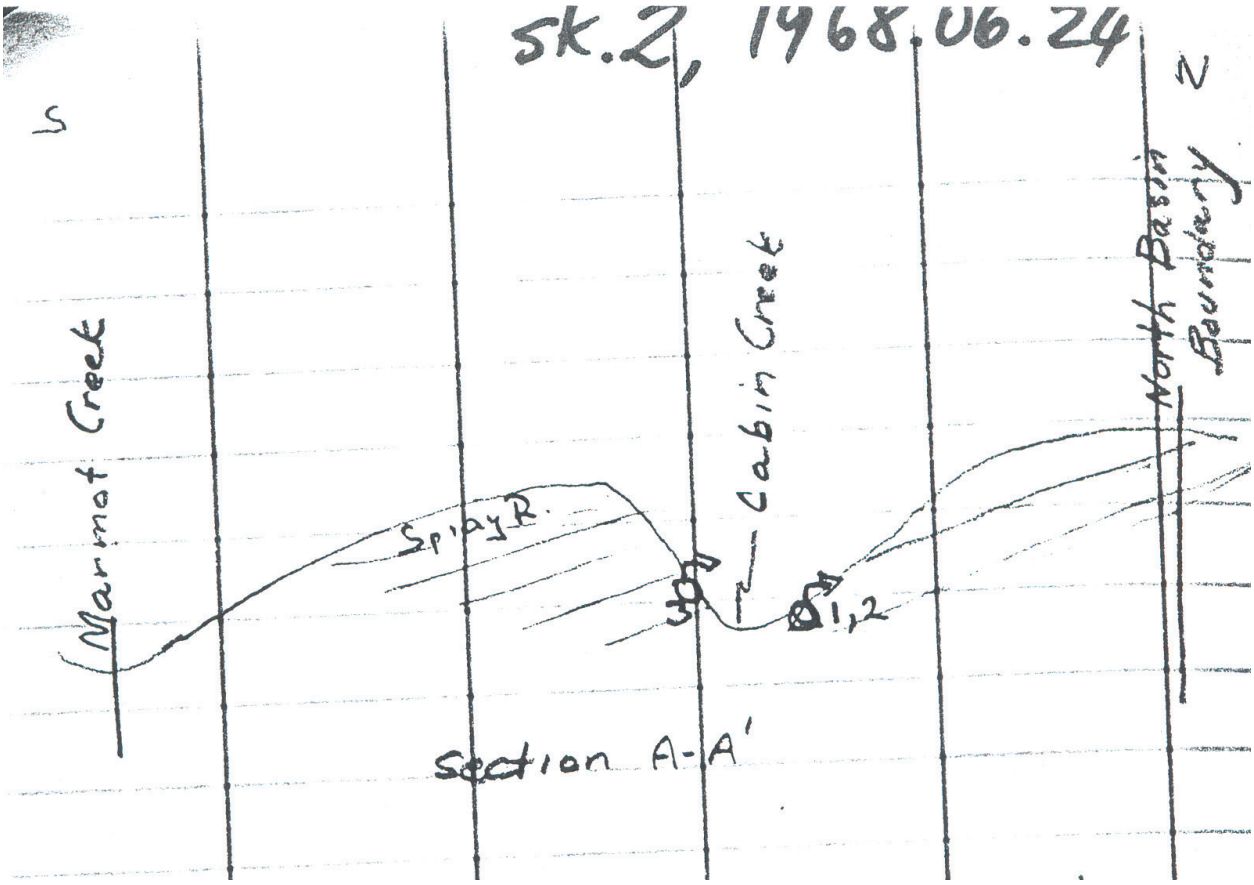
Traverse along Cabin Creek.

Various seeps and springs observed discharging from underneath thick moss cover. Locally calcium carbonate scale is precipitating from spring water.

		T(°F)		Cond.(µmohs/m)
1	33	460		Spr. R. sltst
2	35.5	440	"	
3	35	390	"	
Creek at 1	40	345		
Creek at 2	41.5	315		
Creek at 3	43.5	310		



Sketch – sk. 1, 1968.06.24



Sketch – sk. 2, 1968.06.24

On the basis of conductivity values it is suggested that springs discharging on north banks of Cabin Creek have water that has travelled along a larger flow system, probably more or less along the bedding planes that water discharging at 3). This water would go through a short system, across the bedding and along fractures. Bulk of creek water is from snowmelt.

Photos

Photos 1. spring at 3)

2. Cabin Creek, looking upstream at 3)

Table – tab. 1, 1968.06.24

tab. 1, 1968.06.24

Stop No.		T (F°)	Cond (1/mΩ)	
4	spring	36°	360	Spr. R. sl/st
5	"	33°	390	-"- -"-
Creek at 5		43,5°	305	
6	spring	33,5°	455	Fernie sh
7	-"-	33,5°	460	-"- -"-
Creek at 7		43	300	
8a	Creek	41.5	295	Fernie
9a	Creek	42	295	"
10a	Creek	41°F	275	"
11a	Creek	39°F	300	"
12	Spring	34.5	355	"
12a	Creek	42.5	295	"
13	Spring	60.5	505	"
13a	Creek	43°F	300	"
14	Spring	33°F	335	"
15a	Creek	39.5	265	Kootenay
16a	Creek	35°F	220	"
16b	Snowpack wide	75°F	less than 50	
17	Spring	36°F	245	"
18	Spring	39°F	280	"
19	Spring	36°F	335	"
20	Spring	38°F	115	"
21	"	36.5	140	"
22	"	40.5	380	Fernie
22a	Creek	39°F	180	"
23	Spring	37.5	430	"
24	"	35.5	420	

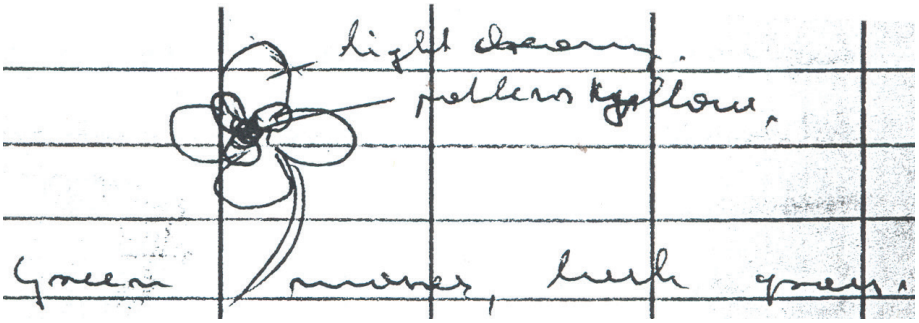
Photos

Photos taken from headwaters area of Cabin Creek to:

1) SSE. Kananaskis Valley with mountains behind, taken across Cabin Creek Valley. (Evan Thomas Gorge in background)
2) E - Kananaskis Valley – mountains.
3) Crossing tributary snow (?) of Cabin Creek.
4) Flowering "Larch" with mountains
5) Flowering "Larch" (close up)
6) Character of tree line on east facing slopes at headwaters of Cabin Creek. Photograph is taken to the north. Gradually increasing tree density (Engelmann spruce) from 0 to full is obvious. Does it have anything to do with the groundwater regime?
7) View of confluence of the three main creeks: from left (north) to right (south): Cabin Creek, Middle Creek, Twin Creek. At center is located the cabin for project workers.
8) Same as above showing the change in vegetation from barren, grass, tree line. (Cond. Reading 18)
9) Spring on the approx. 40° slope side of the mountain on the west end (headwaters) of Middle Creek. The spring is a member of a line of similar springs on the mountain side. It is located above the tree line in the grass field. It is associated with slump-caused depression (seen on 1st photo). The permanent nature is definitely marked by thick moss cover which is strikingly different from the surrounding grass and shrubs.

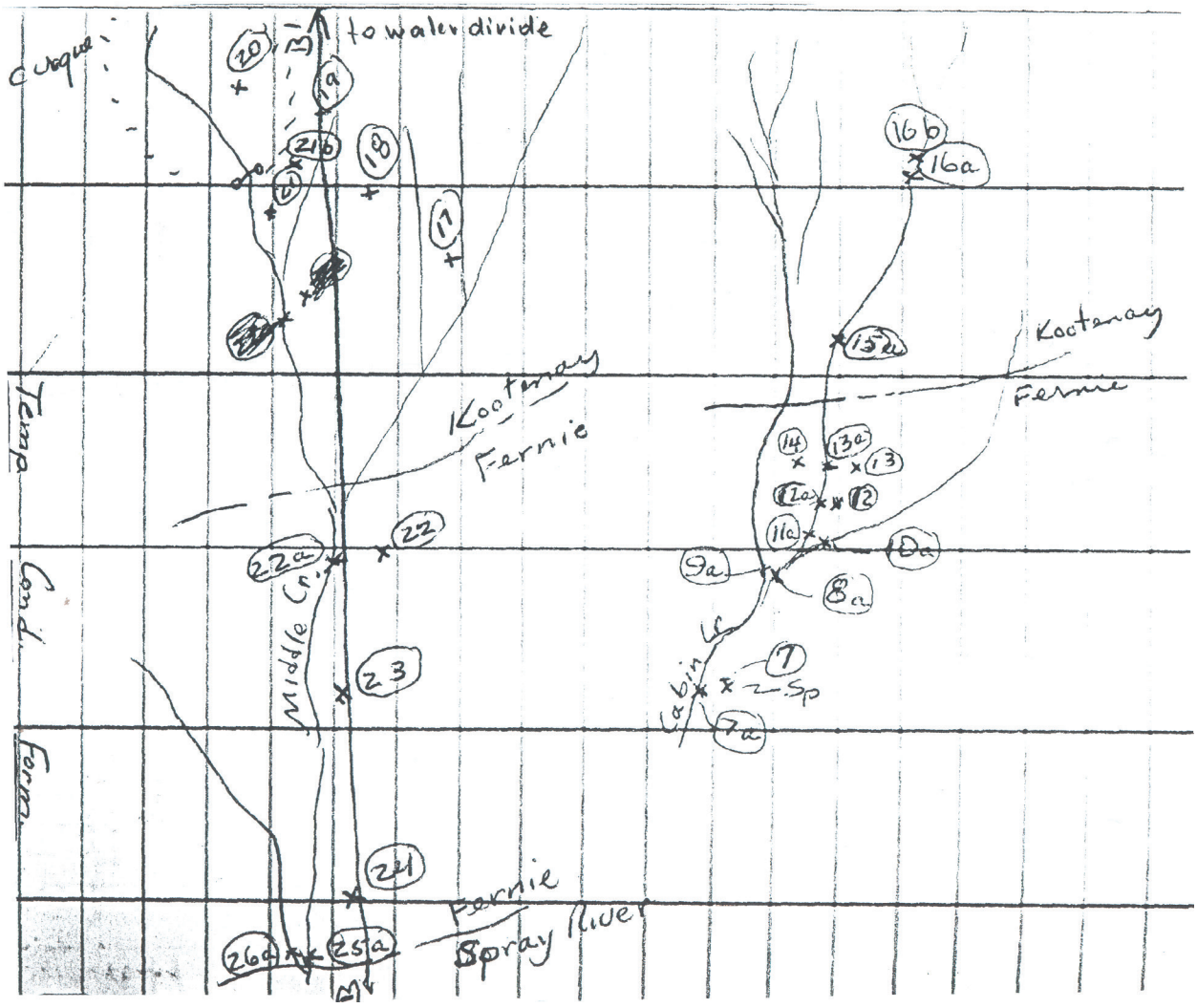
Photo: close up of same spring; discharge 2-4 gpm.
(100 m south of previous: Cond. Read. 19)
Photo: Spring similar to previous one showing striking deep-green coloured moss cover discharging approx. 5 gpm. No salt precipitates in any of these springs.
(Conductivity reading 20)
Photo: Morphology of springs (cirque springs) discharging on mountain side. Sparse but uniform fir – larch – mixed tree cover.

The circular, semi-opened depressions associated with the springs attain 30-50 m in length along the strike and 20 m width perpendicular to the strike of the hill side. Many of these seeps and springs are present some of them fusing on the sides.
Photo: of stop 21b. Terrace seepage, typical of the side of the mountain at north banks of the headwaters of Middle Creek. Creamy-yellow flowers are typical of moist areas. 7 petals:



Sketch – sk. 3, 1968.06.24

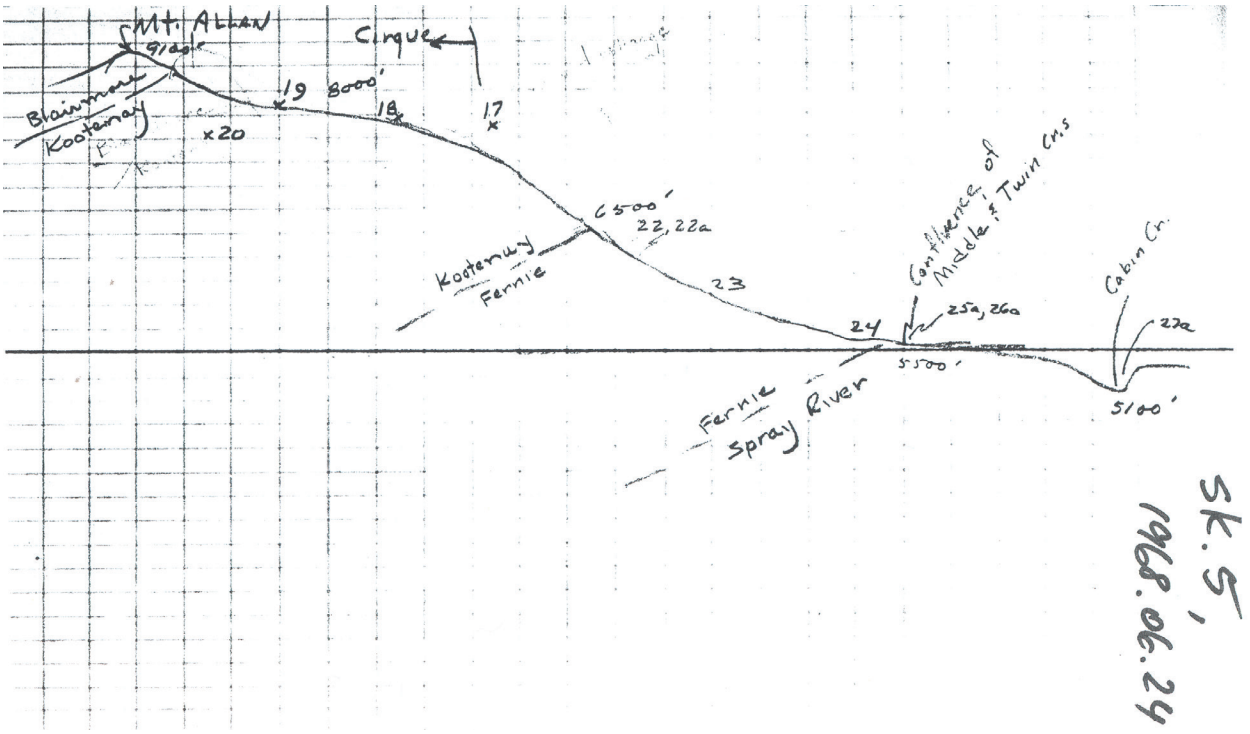
Green mosses, lush grass.
These terraces are found from the first seeps noted (photo 9).



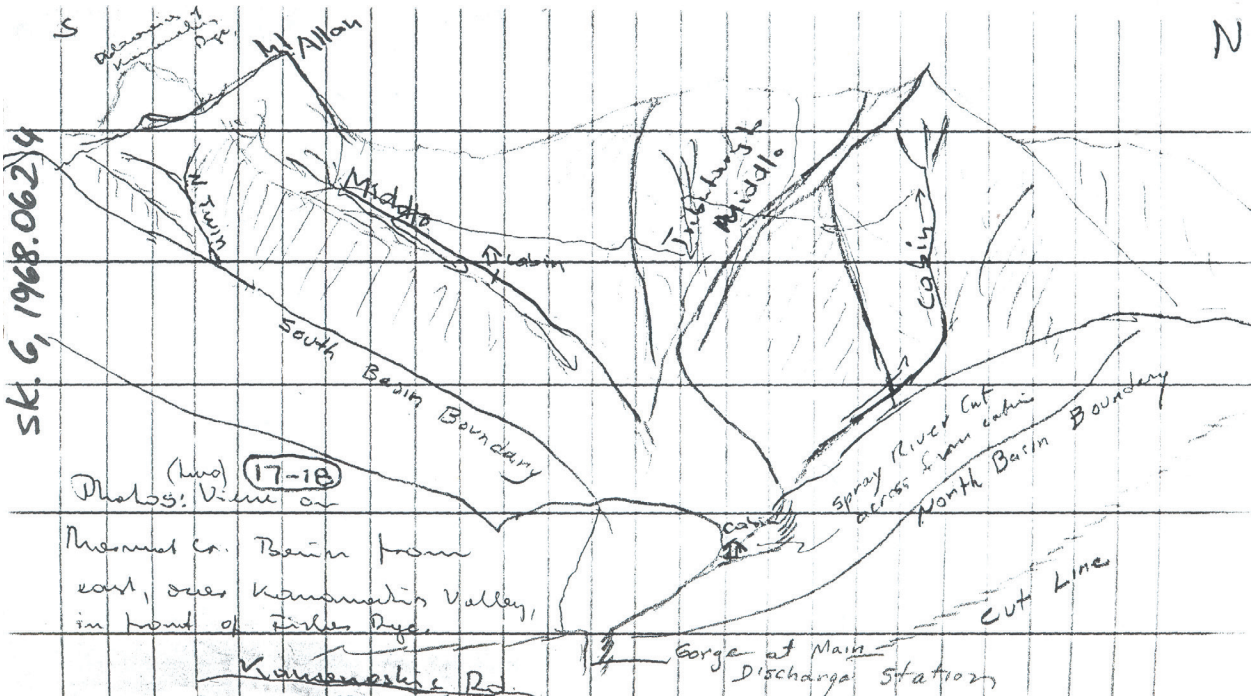
Sketch – sk. 4, 1968.06.24

Table – tab. 2, 1968.06.24

No.		Temp	Cond.	Form.	
25a	Creek	40°	185	Spray River	
26a	"	38°	160	"	
27a	"	40	330	"	
28a	"	40	200	"	
29a	"	41	215	Rocky Mtn	



Sketch – sk. 5, 1968.06.24



Sketch – sk. 6, 1968.06.24

Photos
Photos (2): View on Marmot Creek Basin from east, over Kananaskis Valley, in front of Fisher Range.

June 26, 1968

Tri Creek basin

Stop 1
Lake near junction of Kaydee Wells.

Swamp water at Lake:

T=65°F C<50 µmohs/m
Elev.: 4675 ft.

Stop 2
Creek

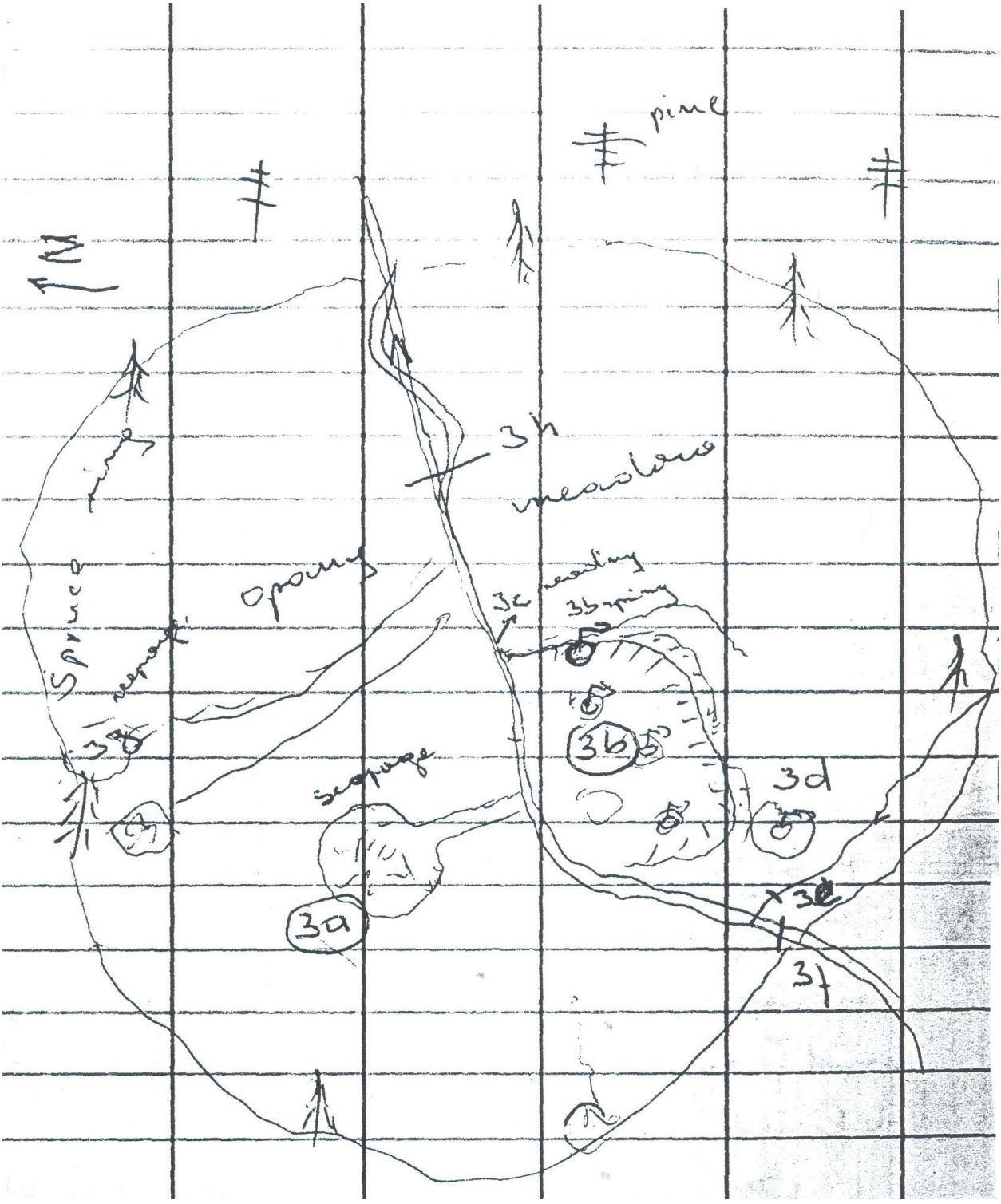
T=49°F C=140 µmohs/m
(tributary to Eurice)

Stop 3
Meadow with seepages and springs at confluence of two tributaries to Eurice (few hundred yards downstream from stop 2).
Large open grassy meadow, edges lined with black spruce, beyond which pine grows. Circular (5 m diameter (30)) seepage on north side of creek approx. 15 m from it. 1-2 gpm discharges into creek. Water is

T=61°F C=200 µmohs/m.

Center part is slightly elevated and moss covered. Channel connecting seepage and creek is grassy but well defined.

On opposite side large (40 m) slumped, semi-circular washout discharging water at many spots. Obviously, this marked out depression, now fused with the creek is a further developed form of the first seepage.



Sketch – 1968.06.26

Meadow is surrounded by hills.

Photos

Photos 1) large slump (groundwater washout) on south bank of creek.

2) 3a seepage with creek and groundwater washout in background

3) 3a seepage with discharge channel.

Meadow is generally soggy, with open water locally between hummocks. Numerous animal (deer, moose) tracks.

3b) spring T=41°F C=215 µmohs/m

3c) creek T=49°F C=115 µmohs/m

3e) creek T=48°F C=115 µmohs/m
Fish observed in stream, indicating permanent nature.

3f) T=49°F C=112 µmohs/m

Photos

Photo: 3g seepage, similar in appearance to 3a, with shovel pushed to steel. 3 m in diameter. Ground is shaky. Jump's impulse felt 15 m away.
Seepage 3g discharges approx. ½ gpm but this water gradually disappears in the channel and stops 20 m from the seepage, although channel is well defined. Analogy with Streeter problem!
Main creek becomes partially underground at point 3h.

Stop 4

4a) creek (a) before confluence T=49°F C=117 µmohs/m

4b) creek (b) before confluence T=48°F C=118 µmohs/m

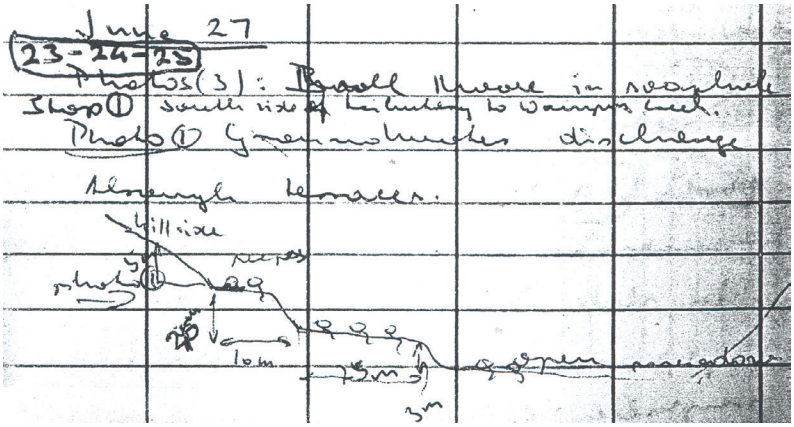
Stop 5

CreekT=49.5°F C=118 µmohs/m

June 27, 1968

Photos

Photos (3): Bull Moose in soap hole; Stop 1) south side of tributary to Wampus (?) Creek.
Photo 1): Groundwater discharge through terraces.



Sketch – 1968.06.27

Photo 1) taken from hillside. Terraces with discharging water shown, with boggy meadow in background. Conductivity 85 μmohs/m . Lower terrace tramped by deer, elk, moose. Tree trunks rubbed smooth. Spring area resembles watering trough for cattle at farm.
Total discharge in order of few gall / min.
Location is approx. 1300 ft. NE of rise of 220 ft. relative elevation.

July 14, 1969

Visit: O. Tokarsky
Lv. Edmonton 8:00 AM
Arr. Mulhurst cabins: 10:30 AM
Lv. Mulhurst: 12:00 noon
Arr. Caroline: 9:30 PM

Traverse along east side of Rocky Mt. House map sheet. Start at Pigeon Lake. Going south, to Dick Lake, past Gull Lake, through Forshee; West to Hespero. Well site is two miles S of Hespero. Cont'd farther south and west to Butte, South to Caroline.

The Northeastern part of the area is characterized by very well defined drainage basins. Examples are the valleys of Battle River, Lloyd Creek, Blindman River, Muskeg Creek, etc. All of these valleys are deeply incised (several hundred feet); single basins; have short basin spans (3-5 mi.); and drain to SE.
The contrast between recharge and discharge areas is very marked.
Discharge area have numerous large (50 to few hundred gpm) springs and active seepages. Muskeg vegetation is commonly associated.
Southward, the intensity of discharge appears to decrease. Springs become smaller.
(Depths are quoted out of memory and are not accurate.)
Test hole had water between 50 and 97 ft. Below that depth to the present 480 ft. rock was mainly shale with relatively little water. No bail test was run between 115 and 480 ft., before 8 5/8" casing was set at 430. Rest of hole was caving so badly that 7" casing is being run now.
=> Caving shale may mean water!
The event of the day was the discovery and rate estimate of a spring discharge just north (1 mi.) of Butte. Large alluvial gravel plain is surrounded by raising land. At one farm several springs combine to form a total stream of about 10,000 gpm!

About ¾ mi. SE of this, there is another spring also discharging several thousand gallons per minute. These huge discharges are reported to be permanent although fluctuating with precipitation. They remain open in the winter.

According to Orest several similar gravel floodplains exist in the area.
The new discovery and expected reporting of this type of water occurrence alone is a complete justification for the reconnaissance mapping!

July 15, 1969

Lv. Caroline: 9:00 AM
Mocharinas north of Caroline
Major Question: Can the different types of marshes be interpreted in terms of hydrogeologic causes?

The main types of marshes are:
1) Sphagnum – black spruce (Muskeg)

2) Black spruce – sedge (Mocharina)

3) Sedge (sedge bog; slough)

These marshes may be considered simply as identifiable members of a continuous spectrum of moisture conditions.

Stop: Travertine spring
NE corner 8-29-42-6W5, elevation 3400 ft.

Hill side spring; approx. 10 gpm.
Discharging from coarse, quicksand 60 ft above road. Various seeps along road. Major travertine deposits associated with discharge water on hillside. Water issuing from spring goes back underground a few meters from spring location. Two more springs, much less intensive, found on both sides of main spring, along the same contour line, and at approx. 50 meters, each.

Photos
Photos (2): travertine deposits from spring water.
Spring is located on West side of mountain, or hill. Hill forms part of a rim surrounding a major topographic depression, several miles across in E-W direction. The road marks a dividing line between markedly different plant associations. Above the road, poplar, aspen, etc. Under road level: spruce, black spruce, aspen, willow, etc.

Spring occurs on tip of hill nose.

August 19, 1969

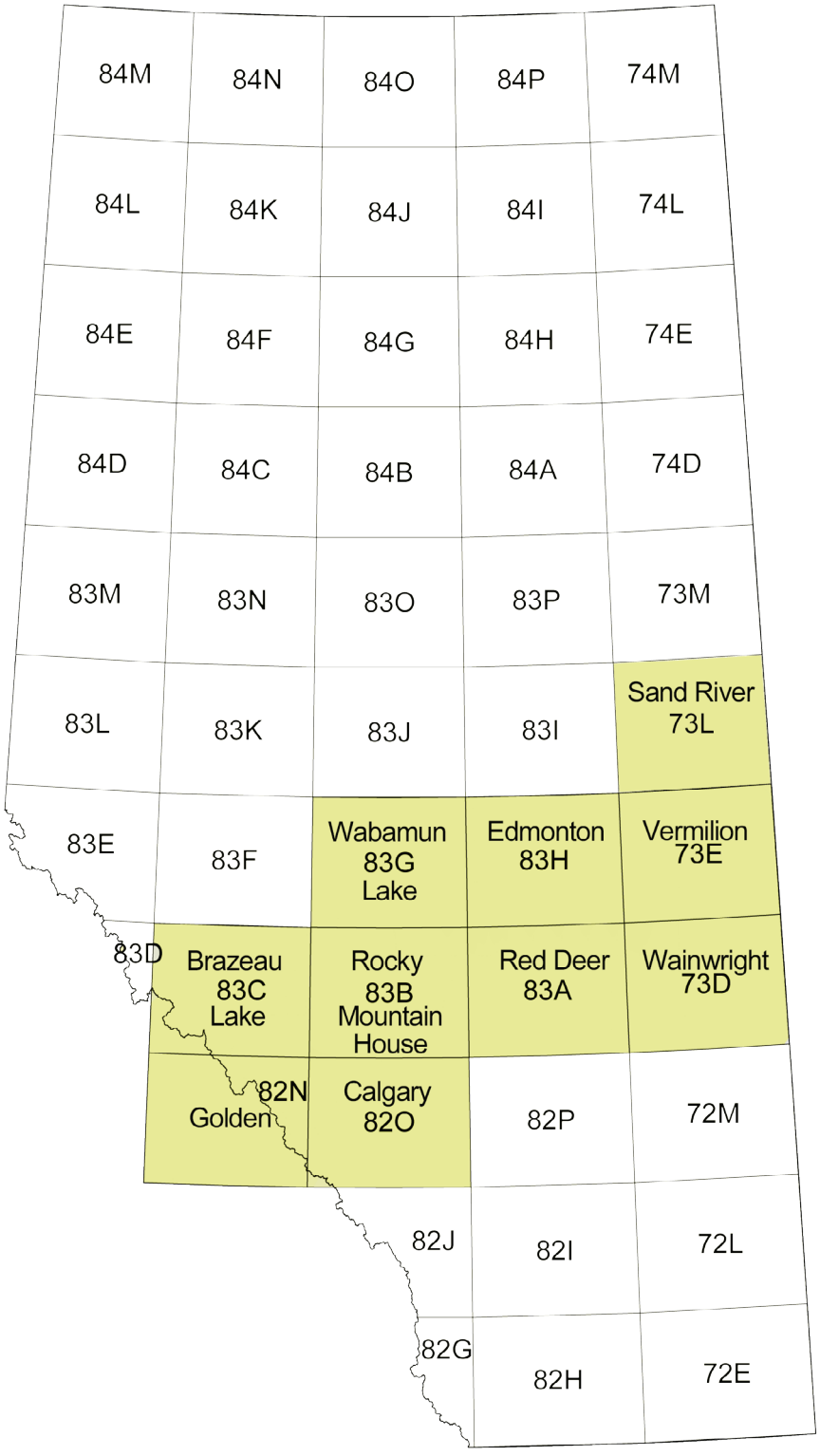
Large Prairie Spring: 12-35-26-23W4 (Rockyford)
Tributary valley to Serviceberry Creek. Approx. 150 m wide at the edge of steep banks and 20 m deep. Water issues from fractured bedrock at various points forming one major circular head-depression. Several semi-circular side-depressions attached to flanks discharge water through small springs. Upstream from main depression sharp V-shaped gully carries surface runoff and some seepage water. Bottom vegetation is dominated by rushes and sedges. Very heavy alkali salts on grass stalks, rocks, and ground. Water is not used by farmer because of poor quality (sodium sulphate). Q is probably over 100 gpm

Photos
Photos: general appearance towards head.

Soap hole
An area of approx. 25 x 10 m is covered with a thick crust of extruded bentonitic clay, and is situated on the bottom of a broad (80 m wide) and approx. 10 m deep coulee. At various places of the muddy crust conical mounds rise obviously discharging water and oozing mud at their apex. The texture and consistency of the mud discharges from different cones may be different. The different discharges coalesce with sharp boundaries.

The ground surrounding the soap hole displays large cracks, some of them filled with polygonally cracked bentonitic muck-crust.
Large (10 m), shallow, bowl like depressions also are found in surrounding.
General area is dry, but (now mostly wilted) phreatophytes (rushes) cover valley bottom.

Appendix 1 – Alberta NTS Map with Highlighted Regions of Fieldwork Conducted by Dr. József Tóth, 1964–1969



BRAZEAU LAKE
83 C
EDITION 2 ÉDITION

Military users, refer to this map as: / Référence de cette carte pour usage militaire:
SERIES A 502 SÉRIE
MAP 83 C CARTE
EDITION 2 MCE ÉDITION

TEN THOUSAND METRE
UNIVERSAL TRANSVERSE MERCATOR GRID
ZONE 11
QUADRILLAGE UNIVERSEL TRANSVERSE DE MERCATOR
DE DIX MILLE MÈTRES

GRID ZONE DESIGNATION / DÉSIGNATION DE LA ZONE DU QUADRILLAGE: 11 U

100 000 m SQUARE IDENTIFICATION / IDENTIFICATION DU CARRÉ DE 100 000 m
MU NU
MT NT
5 58

EXAMPLE OF METHOD USED TO GIVE A REFERENCE TO NEAREST 1000 METRES
EXEMPLE DE LA MÉTHODE EMPLOYÉE POUR FIXER DES REPÈRES À 1000 MÈTRES PRÈS

REFERENCE POINT / POINT DE REPÈRE: CHURCH - ÉGLISE (as above / ci-dessus)

SQUARE. Read letters of 100 000m square / CARRÉ. Lire les lettres du carré de 100 000m: NU

EASTING. Read number on grid line immediately to left of point. / ABSCISSE. Noter le chiffre de la ligne du quadrillage immédiatement à gauche du repère. Estimate tenths of a square from this line eastward to point. / Estimer le nombre de dixièmes du carré entre cette ligne et le repère en direction est: 4 5 45

NORTHING. Read number on grid line immediately below point. / ORDONNÉE. Noter le chiffre de la ligne du quadrillage immédiatement en dessous du repère. Estimate tenths of a square from this line northward to point. / Estimer le nombre de dixièmes du carré entre cette ligne et le repère en direction nord: 0 4 04

GRID REFERENCE / RÉFÉRENCE AU QUADRILLAGE: NU4504

If reporting beyond 18° in any direction, prefix Grid Zone designation as: 14VNU4504
Si vous faites connaître votre position à quelqu'un qui se trouve à plus de 18°, peu importe la direction, indiquez également la zone du quadrillage tel que:14VNU4504

1975
1979
1983
Updated for features visible on 1990 satellite imagery.
Mise à jour pour illustrer les éléments cartographiques visibles sur les images satellite de 1990.

PRODUCED BY THE CANADA CENTRE FOR MAPPING, DEPARTMENT OF ENERGY, MINES AND RESOURCES. UPDATED FROM LARGE SCALE MAPS. INFORMATION CURRENT AS SHOWN IN DIAGRAM. PUBLISHED 1995.

COPIES MAY BE OBTAINED FROM THE CANADA MAP OFFICE, DEPARTMENT OF ENERGY, MINES AND RESOURCES, OTTAWA, OR YOUR NEAREST MAP DEALER.

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Information concerning bench marks and horizontal survey monuments can be obtained from Geodetic Survey, Canada Centre for Surveying, Ottawa.

Pour tout renseignement concernant les repères de nivellement et les bornes géodésiques, prière de s'adresser à la Division des levés géodésiques, Centre canadien des levés, Ottawa.

Roads: / Routes:
hard surface ... pavée ... dual highway, 2 chaussées séparées, 2 lanes / more than 2 lanes, plus de 2 voies
hard surface ... pavée ... 2 lanes / less than 2 lanes
loose or stabilized surface, all weather ... gravier, agglomeré, toute saison ... 2 lanes or more / less than 2 lanes
loose surface, dry weather ... de gravier, temps sec ... 2 voies ou plus / moins de 2 voies
cart track ... de terre
trail, cut line or portage ... sentier, percée ou portage

FOR COMPLETE REFERENCE SEE REVERSE SIDE POUR UNE LISTE COMPLÈTE DES SIGNES, VOIR AU VERSO

BRAZEAU LAKE
ALBERTA BRITISH COLUMBIA
ALBERTA COLOMBIE-BRITANNIQUE

Scale 1:250 000 Échelle
Miles 5 0 5 10 15 20 Miles
Kilometres 5 0 5 10 15 20 25 30 Kilometres

Magnetic declination 1995 varies from 20°51' easterly at centre of west edge to 20°12' easterly at centre of east edge. Mean annual change decreasing 8.2'.

En 1995, la déclinaison magnétique varie de 20°51' vers l'est au centre du bord ouest à 20°12' vers l'est au centre du bord est. La variation annuelle moyenne décroît de 8.2'.

ÉTABLIE PAR LE CENTRE CANADIEN DE CARTOGRAPHIE, MINISTÈRE DE L'ÉNERGIE, DES MINES ET DES RESSOURCES. MISE À JOUR À L'AIDE DE CARTES À GRANDE ÉCHELLE. RENSEIGNEMENTS À JOUR TELS QU'INDIQUÉS DANS LE DIAGRAMME. PUBLIÉE EN 1995.

CES CARTES SONT EN VENTE AU BUREAU DES CARTES DU CANADA, MINISTÈRE DE L'ÉNERGIE, DES MINES ET DES RESSOURCES, OTTAWA, OU CHEZ LE VENDEUR LE PLUS PRÈS.

© 1995. SA MAJESTÉ LA REINE DU CHEF DU CANADA, MINISTÈRE DE L'ÉNERGIE, DES MINES ET DES RESSOURCES.

CONVERSION SCALE FOR ELEVATIONS
Metres 30 20 10 0 50 100 150 200 250 300 Mètres
Feet 100 50 0 100 200 300 400 500 600 700 800 900 1000 Pieds
CONTOUR INTERVAL 200 FEET BELOW 5000 FEET
CONTOUR INTERVAL 500 FEET ABOVE 5000 FEET
Elevations in Feet above Mean Sea Level
North American Datum 1983
Transverse Mercator Projection

ÉCHELLE DE CONVERSION DES ALTITUDES
ÉQUIDISTANCE DES COURBES 200 PIEDS AU-DESSOUS DE 5000 PIEDS
ÉQUIDISTANCE DES COURBES 500 PIEDS AU-DESSUS DE 5000 PIEDS
Altitudes en pieds
Système de référence géodésique nord-américain, 1983
Projection transverse de Mercator

120° 114° 54°
83 E | 83 F | 83 G
83 D | 83 C | 83 B
82 M | 82 N | 82 O
51° 120° 114°
Index to adjoining Maps of the National Topographic System
Tableau d'assemblage du Système national de référence cartographique

MAP TOWN
10815 - 100 Ave. N.W.
Edmonton, AB T5J 4X4
Tel. 429-2600

BRAZEAU LAKE
83 C
EDITION 2 ÉDITION

Energy, Mines and Resources Canada / Énergie, Mines et Ressources Canada

Refer to this map as: 83 C EDITION 1 ASE SERIES A 502

BRAZEAU

ALBERTA - BRITISH COLUMBIA

WEST OF FIFTH MERIDIAN - OUEST DU CINQUIEME MÉRIDIEN

Scale 1:250,000 Echelle

Miles 5 0 5 10 15 20 Miles

Kilometres 5 0 5 10 15 20 25 30 Kilometres

Transverse Mercator Projection
North American Datum 1927
Contour interval 200 feet below 5000 feet
Contour interval 500 feet above 5000 feet
Elevations in feet above Mean Sea Level

Projection Transverse de Mercator
Réseau géodésique nord-américain unifié 1927
Équidistance des courbes 200 pieds au-dessous de 5000 pieds
Équidistance des courbes 500 pieds au-dessus de 5000 pieds
Élévations en pieds au-dessus du niveau moyen de la mer

Compiled by the SURVEYS AND MAPPING BRANCH
DEPARTMENT OF MINES AND TECHNICAL SURVEYS
1960 from large scale maps. Printed 1962

Copies may be obtained from the Map Distribution Office, Department of Mines and Technical Surveys, Ottawa.

Compilée par la DIRECTION DES LEVÉS ET DE LA CARTOGRAPHIE, MINISTÈRE DES MINES ET DES RELEVÉS TECHNIQUES, en 1960, d'après les cartes à large échelle. Imprimée en 1962

Ces cartes sont en vente au Bureau de distribution des cartes, ministère des Mines et des Relevés techniques, Ottawa.

Road
hard surface, all weather ... pavée, toute saison ... more than 2 lanes plus de 2 voies | 2 lanes 2 voies | less than 2 lanes moins de 2 voies
loose surface, all weather ... de gravier, toute saison ... 2 lanes or more 2 voies ou plus | less than 2 lanes moins de 2 voies | dry weather pistes sèches
wagon, cart track ... chemin de terre ... trail or portage ... sentier ou portage

Railway, normal gauge ... Chemin de fer, écartement normal ... Multiple track Voies multiples | Standard gauge Voie normale | Single track Voie unique | Abandoned Abandonnée

Depression contours ... Courbes de cuvette

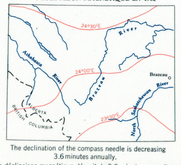
Spot elevation, in feet ... Repère de nivellement en pieds ... 2550

Power transmission line ... Ligne de transport d'énergie

Town ... Ville
Village or Settlement ... Village ou hameau
Post office ... Bureau de poste
Church ... Église
School ... École
Boundary monument ... Borne frontière
Horizontal control point ... Point géodésique

Stream intermittent or dry ... Cours d'eau intermittent ou à sec
Intermittent lake ... Lac intermittent
Rapids; falls ... Rapides; chutes
Marsh or swamp ... Marais ou marécage
Lighthouse ... Phare
Airport ... Aéroport
Seaplane base ... Base d'hydravions

THE DECLINATION OF THE COMPASS NEEDLE 1962
DÉCLINAISON MAGNÉTIQUE EN 1962



The declination of the compass needle is decreasing 3.6 minutes annually.
La déclinaison magnétique décroit de 3.6 minutes annuellement

Index to adjoining sheets of National Topographic System
Tableau d'assemblage du Système de Référence Cartographique National

BRAZEAU
83C
EDITION 1 ASE

GRID ZONE DESIGNATION
11U

100,000 M. SQUARE IDENTIFICATION
MJ NJ
MH NH
58

TO GIVE A REFERENCE TO NEAREST 1000 METRES
EXAMPLE: CABIN
SQUARE: Read letters of 100,000 m. square NJ
EASTING: Read number on grid line immediately to left of point. Estimate tenths of a square from this line eastward to point. 3 3
NORTHING: Read number on grid line immediately below point. Estimate tenths of a square from this line northward to point. 3 8
MILITARY GRID REFERENCE (to nearest 1,000 metres) NJ 3338

If reporting beyond 18° in any direction, prefix Grid Zone Designation as: 11UNJ3338

TEN THOUSAND METRE
UNIVERSAL TRANSVERSE MERCATOR GRID
ZONE 11

Jasper 152 km
Rocky Mountain House 173 km
118°00′
117°00′
116°00′
52°00′
51°00′
45′
30′
15′
440000m.E.
560000m.E.
5750000m.N.
5660000m.N.
Columbia River
Kootenay River
Bow River
Athabasca River
Saskatchewan River
Sullivan Arm
Adamant Range
Selkirk Mountains
Rocky Reach
Blackwater Range
Esplanade Range
Purcell Mountains
Continental Ranges
Warbutik Mountains
Waputik Mountains
Ottertail Range
Beaverfoot Range
Brisco Range
Dogtooth Mountains
Horse Range
Hughes Range
Ranges
Columbia Mountains
Duncan Mountains
Selkirk Mountains
Rocky Mountains
Parc national de Banff
Parc national de Kootenay
Parc national du Mont-Revelstoke
Glacier National Park
Yoho National Park
Kootenay National Park
Banff National Park
Mount Revelstoke National Park
Burgess and James Gadsden Provincial Park
Marl Creek Provincial Park
Donald
Golden
Beavermouth
Redgrave
Nicholson
Leanchoil
Parson
Castledale
Edelweiss
Moberly
Forde
Sturdee
Rogers
Mount Sir Donald
Mount Temple
Mount Assiniboine
Mount Robson
Mount Columbia
Mount Forbes
Mount Goodsir
Mount Balfour
Mount Gordon
Mount Baker
Mount Lefroy
Mount Victoria
Mount Hungabee
Mount Deltaform
Mount Sheppard
Mount Collier
Mount Bell
Mount Patterson
Mount Harris
Mount Willingdon
Mount Wilson
Mount Ball
Mount Stephen
Mount Dennis
Mount Burgess
Mount Cathedral
Mount Field
Mount Odaray
Mount Dawson
Mount Ogden
Mount Carnarvon
Mount Vaux
Mount Hunter
Mount Goodsir
Mount Deltaform
Mount Balfour
Mount Gordon
Mount Baker
Mount Lefroy
Mount Victoria
Mount Hungabee

82 N 1:250,000 CANADA EDITION 1 82 N

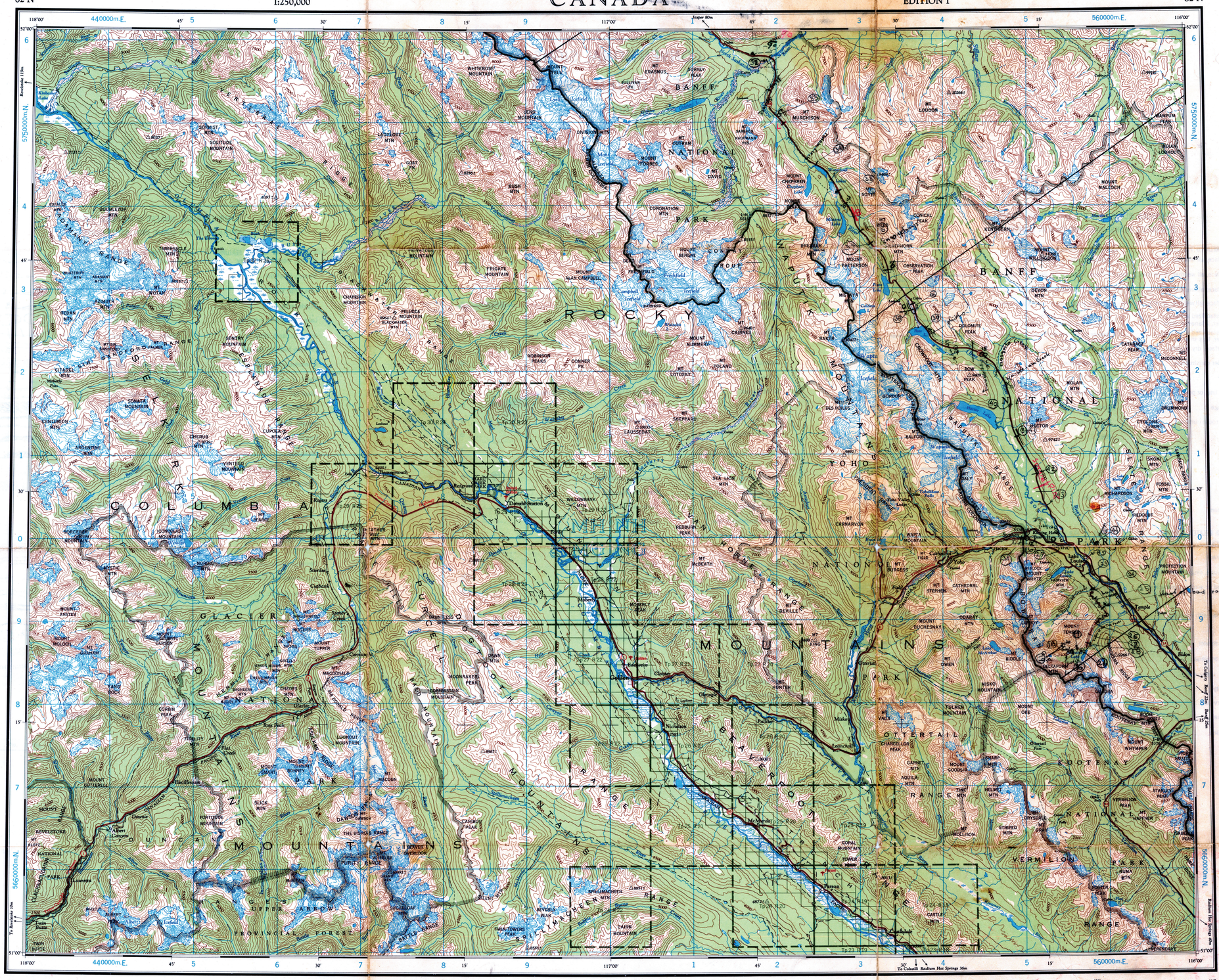
GOLDEN

BRITISH COLUMBIA - ALBERTA

WEST OF FIFTH MERIDIAN

Scale 1:250,000 Échelle

Refer to this map as: 82 N EDITION 1 ASE SERIES A 502



COMPILATION DIAGRAM - SOURCES UTILISÉES

A - Large scale topographic maps, photogrammetric, 1961
B - Large scale topographic manuscripts, photogrammetric, 1962.

A - Cartes topographiques et photogrammétriques à grande échelle, de 1961.
B - Manuscrits topographiques et photogrammétriques à grande échelle, de 1962.

Produced by the ARMY SURVEY ESTABLISHMENT, R.C.E.
Information depicted current as of 1963. Printed 1966.

1964 Magnetic declination for this map varies from 23°26' easterly at the centre of the west edge to 23°04' easterly at the centre of the east edge. Annual change decreasing 3.4'

Publiée par le SERVICE TOPOGRAPHIQUE DE L'ARMÉE, (G.R.C.). Renseignements à jour en 1963. Imprimée en 1966.

La déclinaison magnétique (1964) varie de 23°26' vers l'est au centre de la bordure ouest de la feuille à 23°04' vers l'est au centre de la bordure est. Variation annuelle décroissante 3.4'

Roads: Routes:
hard surface, all weather ... pavée, toute saison — more than 2 lanes plus de 2 voies — 2 lanes 2 voies — less than 2 lanes moins de 2 voies
loose surface, all weather ... de gravier, toute saison — 2 lanes or more 2 voies ou plus — less than 2 lanes moins de 2 voies
cart track or trail ... de terre ou sentier — dry weather période sèche
Railway, normal gauge ... Chemin de fer, écartement normal — station gare — multiple track voies multiples surveyed levée — tracks pistes — single track sole unique — (abandoned) (abandonné) destroyed mots levée
Township or Parish ... Canton ou Paroisse
Depression contours ... Courbes de cuvette
Spot elevation; precise, approximate ... Point coté; précis, approximatif ... • 950 ▪ 950?
Power transmission line ... Ligne de transport d'énergie

Miles 5 0 5 10 15 20 Milles
Kilometres 5 0 5 10 15 20 25 30 Kilomètres

Transverse Mercator Projection
North American Datum 1927
Contour Interval 500 feet
Elevations in feet above Mean Sea Level

Copies may be obtained from the Map Distribution Office, Department of Mines and Technical Surveys, Ottawa.

Projection transverse de Mercator
Réseau géodésique nord-américain unifié 1927
Équidistance des courbes: 500 pieds
Élévations en pieds au-dessus du niveau moyen de la mer

Ces cartes sont en vente au Bureau de distribution des cartes, ministère des Mines et des Relevés techniques, Ottawa.

Town ... Ville — Village or Settlement ... Village ou hameau — Post Office ... Bureau de poste — Church ... Église — School ... École — Boundary monument ... Borne-frontière — Airport ... Aéroport — Seaplane base ... Base d'hydravions

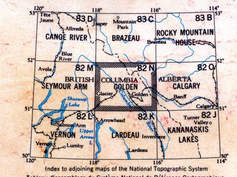
Stream intermittent or dry ... Cours d'eau intermittent ou à sec — Intermittent lake ... Lac intermittent — Rapids; falls ... Rapides; chute — Marsh or Swamp ... Marais ou marécage — Lighthouse ... Phare — Horizontal control point ... Point géodésique — Landing ground ... Piste d'atterrissage — Seaplane anchorage ... Amarrage d'hydravions

GRID ZONE DESIGNATION 11U

100,000 M. SQUARE IDENTIFICATION: MH NH MG NG 57

TO GIVE A REFERENCE TO NEAREST 1000 METRES
EXAMPLE - BRIDGE
SQUARE: Read letters of 100,000 m. square MH
EASTING: Read number on grid line immediately to left of point 8
Estimate tenths of a square from this line eastward to point 6
NORTHING: Read number on grid line immediately below point 0
Estimate tenths of a square from this line northward to point 05
MILITARY GRID REFERENCE (to nearest 1,000 metres) MH8605
If reporting beyond 18° in any direction prefix Grid Zone Designation as: 11UMH8605

TEN THOUSAND METRE UNIVERSAL TRANSVERSE MERCATOR GRID ZONE 11



Index to adjoining maps of the National Topographic System
Tableau d'assemblage du Système National de Référence Cartographique

GOLDEN
82 N
EDITION 1

Refer to this map as: 82-O EDITION 2 ASE SERIES A 502

CALGARY

ALBERTA - BRITISH COLUMBIA

WEST OF FIFTH MERIDIAN - OUEST DU CINQUIÈME MÉRIDIEN

Scale 1:250,000 Échelle

Miles 5 0 5 10 15 20 Milles

Kilometres 5 0 5 10 15 20 25 30 Kilometres

Transverse Mercator Projection
North American Datum 1927
Contour Interval 500 feet
Elevations in feet above Mean Sea Level

Copies may be obtained from the Map Distribution Office, Department of Energy, Mines and Resources, Ottawa.

Projection Transverse de Mercator
Niveau de référence nord-américain, 1927
Équidistance des courbes: 500 pieds
Élévations en pieds au-dessus du niveau moyen de la mer

Ces cartes sont en vente au Bureau de distribution des cartes, ministère de l'Énergie, des Mines et des Ressources, Ottawa.

Produced, 1964, by the SURVEYS AND MAPPING BRANCH, DEPARTMENT OF ENERGY, MINES AND RESOURCES.
Printed 1967.

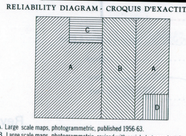
Magnetic declination 1964 varies from 23°04' easterly at centre of west edge to 22°28' easterly at centre of east edge. Mean annual change 3.4' westerly.

Établie en 1964, par la DIRECTION DES LEVÉS ET DE LA CARTOGRAPHIE, MINISTÈRE DE L'ÉNERGIE, DES MINES ET DES RESSOURCES.
Imprimée en 1967.

La déclinaison magnétique pour 1964 varie de 23°04' Est au centre de la limite Ouest à 22°28' Est au centre de la limite Est. Variation moyenne annuelle 3.4' Ouest.

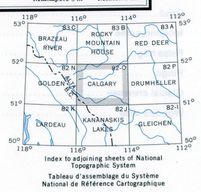
Roads:
hard surface, all weather ..... pavée, toute saison ..... More than 2 lanes plus de 2 voies | 2 lanes 2 voies | Less than 2 lanes moins de 2 voies
loose or stabilized surface, all weather ..... gravier aggloméré, toute saison ..... 2 lanes or more 2 voies ou plus | Less than 2 lanes moins de 2 voies
loose surface, dry weather ..... de gravier, période sèche .....
wagon, cart track ..... chemin de terre .....
trail or portage ..... sentier ou portage .....

RELIABILITY DIAGRAM - CROQUIS D'EXACTITUDE



A. Large scale maps, photogrammetric, published 1956-63.
B. Large scale maps, photogrammetric, revised with aerial photographs taken in 1963.
C. Large scale map, revised with aerial photographs taken in 1955.
D. Detail maps, photogrammetric, published 1961-63.

A. Cartes à grande échelle, photogrammétriques, publiées en 1956-63.
B. Cartes à grande échelle, photogrammétriques, revisées d'après des photographies aériennes prises en 1963.
C. Cartes à grande échelle revisées d'après des photographies aériennes prises en 1955.
D. Cartes détaillées par photogrammétrie, publiées en 1961-63.



Index to adjoining sheets of National Topographic System
Tableau d'assemblage du Système National de Référence Cartographique

GRID ZONE DESIGNATION 11U

100,000 M. SQUARE IDENTIFICATION: NOPQ NPPQ MOPG NPPG 57 6 7

TO GIVE A REFERENCE TO NEAREST 1000 METRES
EXAMPLE: FIRE LOOKOUT TOWER
SQUARE: Read letters of 100,000 m. square PG
EASTING: Read number on grid line immediately to left of point 3
Estimate tenths of a square from this line eastward to point. 4
NORTHING: Read number on grid line immediately below point 34
Estimate tenths of a square from this line northward to point. 9
MILITARY GRID REFERENCE (to nearest 1,000 metres) 99
PG3499

If reporting beyond 18° in any direction, prefix Grid Zone Designation as: 11UPG3499

TEN THOUSAND METRE
UNIVERSAL TRANSVERSE MERCATOR GRID
ZONE 11

CALGARY
82-O
EDITION 2

Refer to this map as: 82-O EDITION 2 ASE SERIES A 502

CALGARY

ALBERTA - BRITISH COLUMBIA

WEST OF FIFTH MERIDIAN - OUEST DU CINQUIÈME MÉRIDIEN

Scale 1:250,000 Échelle

Miles 5 0 5 10 15 20 Milles

Kilometres 5 0 5 10 15 20 25 30 Kilomètres

Transverse Mercator Projection
North American Datum 1927
Contour Interval 500 feet
Elevations in feet above Mean Sea Level

Projection Transverse de Mercator
Niveau de référence nord-américain, 1927
Équidistance des courbes: 500 pieds
Élévations en pieds au-dessus du niveau moyen de la mer

Copies may be obtained from the Map Distribution Office, Department of Energy, Mines and Resources, Ottawa.

Ces cartes sont en vente au Bureau de distribution des cartes, ministère de l'Énergie, des Mines et des Ressources, Ottawa.

Derived, 1964, by the SURVEYS AND MAPPING BRANCH, DEPARTMENT OF ENERGY, MINES AND RESOURCES.
Printed 1967.

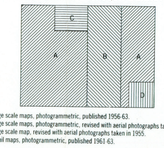
Magnetic declination 1964 varies from 27'04' easterly at centre of west edge to 22'28' easterly at centre of east edge. Mean annual change 3.4' westerly.

Établie en 1964, par la DIRECTION DES LEVÉS ET DE LA CARTOGRAPHIE, MINISTÈRE DE L'ÉNERGIE, DES MINES ET DES RESSOURCES.
Imprimée en 1967.

La déclinaison magnétique pour 1964 varie de 27'04' Est au centre de la limite Ouest à 22'28' Est au centre de la limite Est. Variation moyenne annuelle 3.4' Ouest.

Roads:
hard surface, all weather ..... pavée, toute saison ..... more than 2 lanes plus de 2 voies; 2 lanes 2 voies; less than 2 lanes moins de 2 voies
loose or stabilized surface, all weather ..... gravier agglomeré, toute saison ..... 2 lanes or more 2 voies ou plus; less than 2 lanes moins de 2 voies
loose surface, dry weather ..... de gravier, période sèche .....
wagon, cart track ..... chemin de terre .....
trail or portage ..... sentier ou portage .....

RELIABILITY DIAGRAM - CROQUIS D'EXACTITUDE



A. Large scale maps, photogrammetric, published 1956-63.
B. Large scale maps, photogrammetric, revised with aerial photographs taken in 1963.
C. Large scale map, revised with aerial photographs taken in 1955.
D. Detail maps, photogrammetric, published 1961-63.

A. Cartes à grande échelle, photogrammétriques, publiées en 1956-63.
B. Cartes à grande échelle, photogrammétriques, revisées d'après des photographies aériennes prises en 1963.
C. Cartes à grande échelle revisées d'après des photographies aériennes prises en 1955.
D. Cartes détaillées par photogrammétrie, publiées en 1961-63.

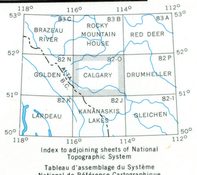


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Tableau d'assemblage du Système National de Référence Cartographique

GRID ZONE DESIGNATION 11U

100,000 M. SQUARE IDENTIFICATION

		NUVQ	NVQ	PUQ	PVQ
		NUPG	NVPG	PUPG	PVPG
		6	7	6	7

TO GIVE A REFERENCE TO NEAREST 1000 METRES
EXAMPLE: FIRE LOOKOUT TOWER
SQUARE: Read letters of 100,000 m. square PG
EASTING: Read number on grid line immediately to left of point. Estimate tenths of a square from this line eastward to point. 3 4 34
NORTHING: Read number on grid line immediately below point. Estimate tenths of a square from this line northward to point. 9 9 99
MILITARY GRID REFERENCE (to nearest 1,000 metres) PG3499
If reporting beyond 18° in any direction, prefix Grid Zone Designation as: 11UPG3499

TEN THOUSAND METRE UNIVERSAL TRANSVERSE MERCATOR GRID ZONE 11

CALGARY
82-O
EDITION 2

Refer to this map as: 83B EDITION 1 ASE SERIES A 502

ROCKY MOUNTAIN HOUSE

ALBERTA

WEST OF FIFTH MERIDIAN - OUEST DU CINQUIÈME MÉRIDIEN

Scale 1:250,000 Échelle

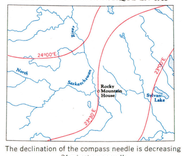
Miles 5 0 5 10 15 20 Miles

Kilometres 5 0 5 10 15 20 25 30 Kilomètres

Transverse Mercator Projection
North American Datum 1927
Contour interval 200 feet below 5000 feet
Contour interval 500 feet above 5000 feet
Elevations in feet above Mean Sea Level

Projection Transverse de Mercator
Réseau géodésique nord-américain unifié (1927)
Équidistance des courbes 200 pieds au-dessous de 5000 pieds
Équidistance des courbes 500 pieds au-dessus de 5000 pieds
Élévations en pieds au-dessus du niveau moyen de la mer

THE DECLINATION OF THE COMPASS NEEDLE 1962
DÉCLINAISON MAGNÉTIQUE EN 1962



The declination of the compass needle is decreasing 3′ minutes annually.
La déclinaison magnétique décroît de 3′ minutes annuellement

Compiled, 1960, by the SURVEYS AND MAPPING BRANCH, DEPARTMENT OF MINES AND TECHNICAL SURVEYS, from large scale maps. Printed 1963.

Copies may be obtained from the Map Distribution Office, Department of Mines and Technical Surveys, Ottawa.

Rédigée en 1960, par la DIRECTION DES LEVÉS ET DE LA CARTOGRAPHIE, MINISTÈRE DES MINES ET DES RELEVÉS TECHNIQUES, d'après les cartes à large échelle. Imprimée en 1963.

Ces cartes sont en vente au Bureau de distribution des cartes, ministère des Mines et des Relevés techniques, Ottawa.

Road / Route
hard surface, all weather ... pavée, toute saison ... more than 2 lanes plus de 2 voies; 2 lanes or more 2 voies ou plus; 2 lanes 2 voies; less than 2 lanes moins de 2 voies
loose surface, all weather ... de gravier, toute saison ... more than 2 lanes plus de 2 voies; 2 lanes 2 voies; less than 2 lanes moins de 2 voies
wagon, cart track ... chemin de terre ... trail or portage ... sentier ou portage
Railway, normal gauge ... Chemin de fer, écartement normal ... station; multiple track; gare; voies multiples; tipple; single track; trémie; voie unique; abandoned; abandonnée
Depression contours ... Courbes de cuvette
Spot elevation, in feet ... Repère de nivellement en pieds ... 2550
Power transmission line ... Ligne de transport d'énergie

Town ... Ville
Village or Settlement ... Village ou hameau ... O
Post office ... Bureau de poste ... P
Church ... Église
School ... École
Boundary monument ... Borne frontière
Horizontal control point ... Point géodésique ... Δ

Stream: Intermittent or dry ... Cours d'eau: intermittent ou à sec
Intermittent lake ... Lac intermittent
Rapids; falls ... Rapides; chutes
Marsh or swamp ... Marais ou marécage
Lighthouse ... Phare
Airport ... Aéroport
Seaplane base ... Base d'hydravions

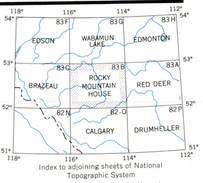


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Tableau d'assemblage du Système de Référence Cartographique National

ROCKY MOUNTAIN HOUSE 83 B
EDITION 1 ASE

100,000 M. SQUARE IDENTIFICATION

GRID ZONE DESIGNATION 11U

NJ PJ PJ01 58
NH PH PH04

TO GIVE A REFERENCE TO NEAREST 1000 METRES
EXAMPLE ... SCHOOL
SQUARE: Read letters of 100,000 m. square ... PJ
EASTING: Read number on grid line immediately to left of point. Estimate tenths of a square from this line eastward to point. ... 4 6
NORTHING: Read number on grid line immediately below point. Estimate tenths of a square from this line northward to point. ... 1 4
MILITARY GRID REFERENCE: its nearest 1,000 metres ... PJ4614

If reporting beyond 18° in any direction prefix Grid Zone Designation as 11UPJ4614

TEN THOUSAND METRE
UNIVERSAL TRANSVERSE MERCATOR GRID
ZONE 11

Refer to this map as: 83B EDITION 1 ASE SERIES A 502

ROCKY MOUNTAIN HOUSE

ALBERTA

WEST OF FIFTH MERIDIAN - OUEST DU CINQUIÈME MÉRIDIEN

Scale 1:250,000 Échelle

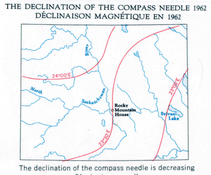
Miles 5 0 5 10 15 20 Milles

Kilometres 5 0 5 10 15 20 25 30 Kilometres

Transverse Mercator Projection
North American Datum 1927
Contour interval 200 feet below 5000 feet
Contour interval 500 feet above 5000 feet
Elevations in feet above Mean Sea Level

Projection Transverse de Mercator
Réseau géodésique nord-américain unifié (1927)
Équidistance des courbes 200 pieds au-dessus de 5000 pieds
Équidistance des courbes 500 pieds au-dessus de 5000 pieds
Élévations en pieds au-dessus du niveau moyen de la mer

THE DECLINATION OF THE COMPASS NEEDLE 1962
DÉCLINAISON MAGNÉTIQUE EN 1962



The declination of the compass needle is decreasing 3′ minutes annually.
La déclinaison magnétique décroît de 3′ minutes annuellement

Compiled, 1960, by the SURVEYS AND MAPPING BRANCH, DEPARTMENT OF MINES AND TECHNICAL SURVEYS, from large scale maps. Printed 1963.

Copies may be obtained from the Map Distribution Office, Department of Mines and Technical Surveys, Ottawa.

Road
hard surface, all weather ... pavée, toute saison ... more than 2 lanes / plus de 2 voies ... 2 lanes / 2 voies ... less than 2 lanes / moins de 2 voies
loose surface, all weather ... de gravier, toute saison ... 2 lanes or more / 2 voies ou plus ... less than 2 lanes / moins de 2 voies ... dry weather / par temps sec
wagon, cart track ... chemin de terre ... trail or portage ... sentier ou portage

Railway, normal gauge ... Chemin de fer, écartement normal ... station / gare ... multiple track / voies multiples ... trackless / sans rails ... single track / voie unique ... tunnel ... bridge / pont

Depression contours ... Courbes de cuvette

Spot elevation, in feet ... Repère de nivellement en pieds ... 1550

Power transmission line ... Ligne de transport d'énergie

Rédigée en 1960, par la DIRECTION DES LEVÉS ET DE LA CARTOGRAPHIE, MINISTÈRE DES MINES ET DES RELEVÉS TECHNIQUES, d'après les cartes à large échelle. Imprimée en 1963.

Ces cartes sont en vente au Bureau de distribution des cartes, ministère des Mines et des Relevés techniques, Ottawa.

Town ... Ville
Village or Settlement ... Village ou hameau ... O
Post office ... Bureau de poste ... P
Church ... Église ... ⅄
School ... École ... ⅄
Boundary monument ... Borne frontière ... ⊡
Horizontal control point ... Point géodésique ... △

Stream: intermittent or dry ... Cours d'eau: intermittent ou à sec
Intermittent lake ... Lac intermittent
Rapids; falls ... Rapides; chutes
Marsh or swamp ... Marais ou marécage
Lighthouse ... Phare
Airport ... Aéroport
Seaplane base ... Base d'hydravions

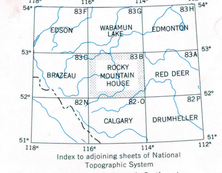


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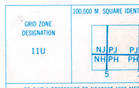
Tableau d'assemblage du Système de Référence Cartographique National

ROCKY MOUNTAIN HOUSE 83 B
EDITION 1 ASE

GRID ZONE DESIGNATION 11U

100,000 M. SQUARE IDENTIFICATION



TO GIVE A REFERENCE TO NEAREST 1000 METRES
EXAMPLE: SCHOOL
SQUARE: Read letters of 100,000 m. square PJ
EASTING: Read number on grid line immediately to left of point. Estimate tenths of a square from this line eastward to point. 46
NORTHING: Read number on grid line immediately below point. Estimate tenths of a square from this line northward to point. 14
MILITARY GRID REFERENCE (to nearest 1,000 metres) PJ4614
If reporting beyond 19° in any direction, prefix Grid Zone Designation as: 11UPJ4614

TEN THOUSAND METRE UNIVERSAL TRANSVERSE MERCATOR GRID ZONE 11

(Leases, etc. applied for, pending, or granted) shown on this map ... (138b)

Restricted Area" Border No. 24 (Alberta Regulation 349/68 Geophysical Regulations in the area where licensing matter occurs. (by letter No. S/62 of R.A. Seaton Director of Minerals.

62.6

NATIONAL TOPOGRAPHIC SYSTEM 1:250,000 CANADA FIRST EDITION SHEET 83 G

WABAMUN LAKE

ALBERTA

WEST OF FIFTH MERIDIAN

Scale 1:250,000

1 inch to 4 Miles Approximately

Miles 5 0 5 10 15 20 Miles

Kilometres 5 0 5 10 15 20 25 30 Kilometres

Universal Transverse Mercator Projection

Contour interval 100 feet
Elevations in Feet above Mean Sea Level
North American Datum 1927

Produced and printed by the SURVEYS AND MAPPING BRANCH, DEPARTMENT OF MINES AND TECHNICAL SURVEYS, 1956.

Copies may be obtained from the Map Distribution Office, Department of Mines and Technical Surveys, Ottawa.

Refer to this Map as:- 83G EDITION 1 ASE SERIES A502

REFERENCE

Roads: hard surface, all weather; loose surface, all weather; wagon; cart track; Railway: normal gauge; Boundaries: international; provincial; Indian reserve, park, etc.; township, surveyed; township, unsurveyed; Section line; more than 2 lanes; 2 lanes; less than 2 lanes; 2 lanes or more; less than 2 lanes; dry weather; Trail or portage; multiple track; single track; abandoned; station; flagstop; Contours: elevation; depression; approximate; Spot elevation (in feet); Power transmission line; Telephone line; City or large town; Town; Village or settlement; Post office; School; Church; Boundary monument; Astronomical position; Horizontal control point; Streams: intermittent or dry; indefinite; Irrigation canal or ditch; Rapids; falls; Aerodrome; Landing ground; Intermittent lake; Marsh or swamp; Sand, gravel or mud; Wooded areas; Seaplane base; Seaplane anchorage

THE DECLINATION OF THE COMPASS NEEDLE 1956

The declination of the compass needle at any place along a red line is the declination given on the red line. At places where the declination is between those given on the neighbouring red lines, thus at the place marked A, the declination is between 24°00'E and 24°30'E. The declination of the compass needle is decreasing 5 minutes annually.

Index to adjoining sheets

WABAMUN LAKE 83 G EDITION 1 ASE

GRID ZONE DESIGNATION 11U

100,000 M. SQUARE IDENTIFICATION: NK PK / NJ PJ; 590; 60; 70

TO GIVE A REFERENCE TO NEAREST 1000 METRES

EXAMPLE: SCHOOL

SQUARE: Read letters of 100,000 m square — PK

EASTING: Read number on grid line immediately to left of point. Estimate tenths of a square from this line eastward to point. — 2 5 25

NORTHING: Read number on grid line immediately below point. Estimate tenths of a square from this line northward to point. — 3 9 39

MILITARY GRID REFERENCE PK2539 (to nearest 1,000 metres)

If reporting beyond 18° in any direction, prefix Grid Zone Designation as: 11UPK2539

TEN THOUSAND METRE UNIVERSAL TRANSVERSE MERCATOR GRID ZONE 11

NATIONAL TOPOGRAPHIC SYSTEM 1:250,000 **CANADA** FIRST EDITION SHEET 83G

Refer to this Map as:- 83G EDITION 1 ASE SERIES A502

WABAMUN LAKE

ALBERTA

WEST OF FIFTH MERIDIAN

Scale 1:250,000

1 Inch to 4 Miles Approximately

Miles 5 0 5 10 15 20 Miles

Kilometres 5 0 5 10 15 20 25 30 Kilometres

Universal Transverse Mercator Projection

Contour interval 100 feet
Elevations in Feet above Mean Sea Level
North American Datum 1927

Produced and printed by the SURVEYS AND MAPPING BRANCH, DEPARTMENT OF MINES AND TECHNICAL SURVEYS, 1956.

Copies may be obtained from the Map Distribution Office, Department of Mines and Technical Surveys, Ottawa.

THE DECLINATION OF THE COMPASS NEEDLE 1956

The declination of the compass needle at any place along a red line is the declination given on that line. Elsewhere the declination is between those given on the neighbouring red lines; thus at the place marked **A**, the declination is between 24°00'E. and 24°30'E. The declination of the compass needle is decreasing 5 minutes annually.

REFERENCE

Roads: more than 2 lanes; 2 lanes; less than 2 lanes
- hard surface, all weather — 2 lanes or more; less than 2 lanes; dry weather
- loose surface, all weather
- wagon; cart track
- Railway: normal gauge — multiple track; single track; abandoned
- Boundaries: international; provincial; Indian reserve, park, etc.; township, surveyed; township, unsurveyed; Section line
- Contours: elevation; depression; approximate
- Spot elevation (in feet) .1865
- Power transmission line
- Telephone line

REFERENCE

- City or large town; Town; Village or settlement
- Post office P; School; Church
- Boundary monument; Astronomical position; Horizontal control point
- Streams: intermittent or dry; indefinite; Irrigation canal or ditch; Rapids; falls
- Intermittent lake; Marsh or swamp; Sand, gravel or mud; Wooded areas
- Aerodrome; Landing ground
- Seaplane base; Seaplane anchorage

Index to adjoining sheets

WABAMUN LAKE 83 G EDITION 1 ASE

GRID ZONE DESIGNATION 11U

100,000 M. SQUARE IDENTIFICATION: NK PK / NJ PJ; 590; 60; 70

TO GIVE A REFERENCE TO NEAREST 1000 METRES

EXAMPLE: SCHOOL

SQUARE: Read letters of 100,000 m. square PK

EASTING: Read number on grid line immediately to left of point 25
Estimate tenths of a square from this line eastward to point. 26

NORTHING: Read number on grid line immediately below point 39
Estimate tenths of a square from this line northward to point. 40

MILITARY GRID REFERENCE PK2539

If reporting beyond 18° in any direction, prefix Grid Zone Designation as: 11UPK2539

TEN THOUSAND METRE UNIVERSAL TRANSVERSE MERCATOR GRID ZONE 11

Refer to this map as: 83 H EDITION 2 ASE SERIES A 502

EDMONTON
ALBERTA
WEST OF FOURTH MERIDIAN - OUEST DU QUATRIÈME MÉRIDIEN

Scale 1:250,000 Échelle

Miles 5 0 5 10 15 Milles

Kilometres 5 0 5 10 20 Kilomètres

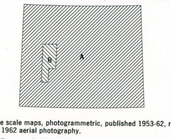
Transverse Mercator Projection
North American Datum 1927
Contour Interval 100 feet
Elevations in feet above Mean Sea Level

Copies may be obtained from the Map Distribution Office, Department of Mines and Technical Surveys, Ottawa.

Projection Transverse de Mercator
Niveau de référence nord-américain, 1927
Équidistance des courbes: 100 pieds
Élévations en pieds au-dessus du niveau moyen de la mer

Ces cartes sont en vente au Bureau de distribution des cartes, ministère des Mines et des Relevés techniques, Ottawa.

RELIABILITY DIAGRAM - CROQUIS D'EXACTITUDE



A - Large scale maps, photogrammetric, published 1953-62, revised with 1962 aerial photography.

B - Detail maps, photogrammetric, published 1961-62, revised with 1962 aerial photography.

A - Cartes à grande échelle, photogrammétrie, imprimées en 1953-62, revisées d'après des photographies aériennes prises en 1962.

B - Cartes détaillées, photogrammétrie, imprimées en 1961-62, revisées d'après des photographies aériennes prises en 1962.

Derived, 1964, by the SURVEYS AND MAPPING BRANCH, DEPARTMENT OF MINES AND TECHNICAL SURVEYS. Printed 1965.

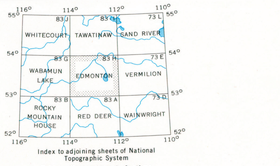
Magnetic declination 1965 varies from 23°15' easterly at centre of west edge to 22°27' easterly at centre of east edge. Mean annual change: 3.9' westerly.

Établie en 1964, par la DIRECTION DES LEVÉS ET DE LA CARTOGRAPHIE, MINISTÈRE DES MINES ET DES RELEVÉS TECHNIQUES. Imprimée en 1965.

La déclinaison magnétique pour 1965 varie de 23°15' Est au centre de la limite Ouest à 22°27' Est au centre de la limite Est. Variation moyenne annuelle: 3.9' Ouest.

Roads:		Routes:
hard surface, all weather	Dual highway / more than 2 lanes	pavée, toute saison
hard surface, all weather	Autoroute / plus de 2 voies / 2 voies / 2 lanes / less than 2 lanes	pavée, toute saison
loose or stabilized surface, all weather	2 lanes or more / 2 voies ou plus / less than 2 lanes / moins de 2 voies	gravier agglomeré, toute saison
loose surface, dry weather		de gravier, période sèche
wagon, cart track	chemin de terre	trail or portage / sentier ou portage
Railway, normal gauge	station / gare / multiple track / voie multiple / single track / voie unique	Chemin de fer, écartement normal
Contours	Courbes de niveau	Depression contours / Courbes de cuvette
Spot elevation in feet 2550.	Repère de nivellement en pieds	Power transmission line / Ligne de transport d'énergie

Stream: intermittent or dry	Cours d'eau: intermittent ou à sec
Intermittent lake	Lac intermittent
Rapids; falls	Rapides; chutes
Marsh or swamp	Marais ou marécage
Lighthouse	Phare
Airport	Aéroport
Seaplane base	Base d'hydravions
Tank, oil, water, etc.	Réservoir, pétrole, eau, etc.
Town	Ville
Village or Settlement	Village ou hameau
Post Office	Bureau de poste
Church	Église
School	École
Boundary monument	Borne frontière
Horizontal control point	Point géodésique
Well, oil or gas	Puits, pétrole ou gaz



Index to adjoining sheets of National Topographic System
Tableau d'assemblage du Système National de Référence Cartographique

GRID ZONE DESIGNATION 12U

100,000 M. SQUARE IDENTIFICATION: UQ/VQ / UP/VP

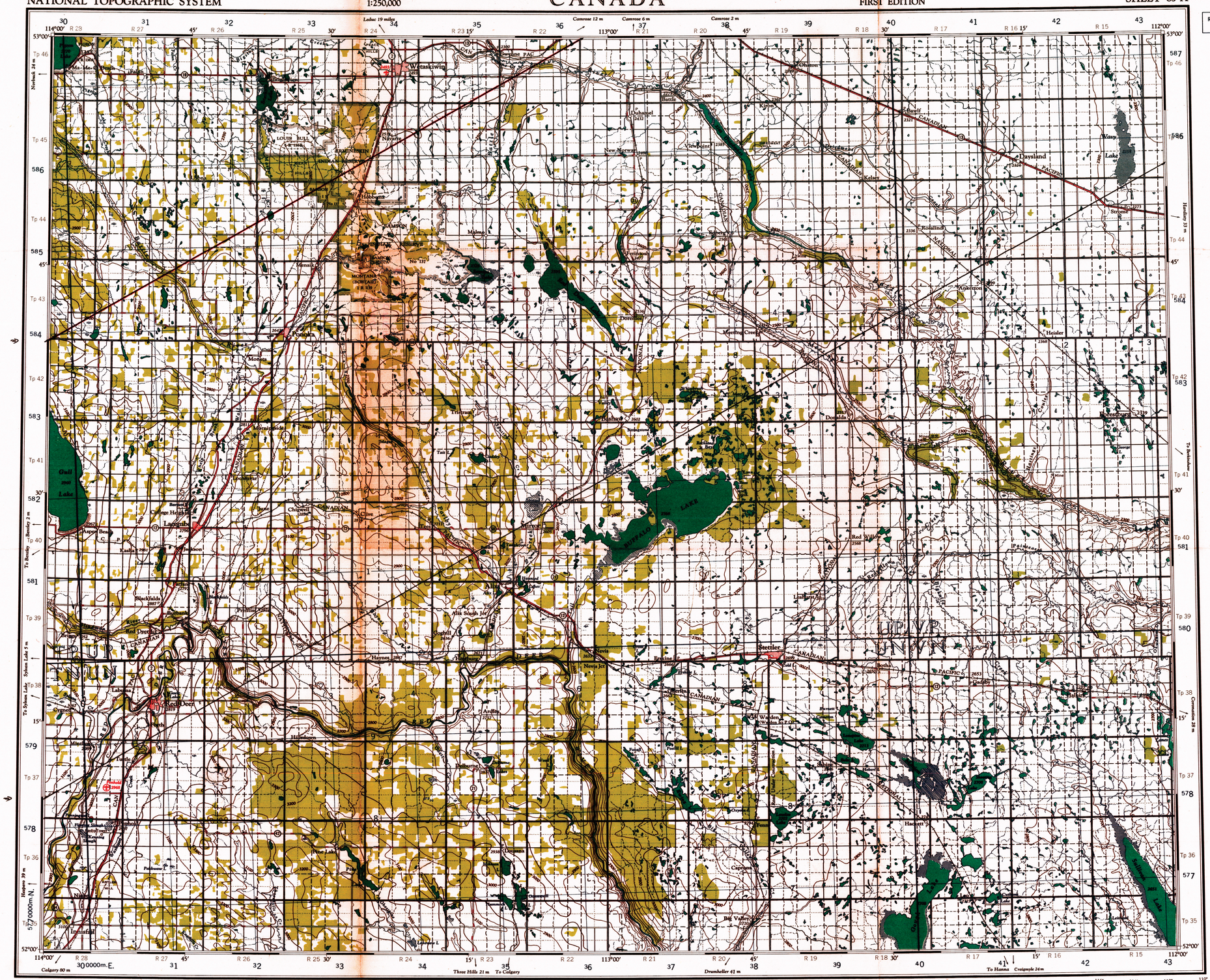
TO GIVE A REFERENCE TO NEAREST 1000 METRES
EXAMPLE: RAILWAY STATION
SQUARE: Read letters of 100,000 m. square UQ
EASTING: Read number on grid line immediately to left of point. Estimate tenths of a square from this line eastward to point. 96
NORTHING: Read number on grid line immediately below point. Estimate tenths of a square from this line northward to point. 10
MILITARY GRID REFERENCE (to nearest 1,000 metres) UQ9610
If reporting beyond 18° in any direction, prefix Grid Zone Designation as: 12UUQ9610

TEN THOUSAND METRE UNIVERSAL TRANSVERSE MERCATOR GRID ZONE 12

EDMONTON
83 H
EDITION 2

NATIONAL TOPOGRAPHIC SYSTEM | 1:250,000 | # CANADA | FIRST EDITION | SHEET 83 A

Refer to this Map as:- 83 A EDITION 1 ASE SERIES A502



THE DECLINATION OF THE COMPASS NEEDLE 1955

The declination of the compass needle at any place along a red line is the declination given on that red line. At other places the declination is between those given on the neighbouring red lines; thus at the place marked A, the declination is between 23°00'E and 23°30'E. The declination of the compass needle is decreasing 4¼ minutes annually.

Produced and printed by the SURVEYS AND MAPPING BRANCH, DEPARTMENT OF MINES AND TECHNICAL SURVEYS, 1958

Universal Transverse Mercator Projection

Contour interval 100 Feet
Elevations in Feet above Mean Sea Level
North American Datum 1927.

Copies may be obtained from the Map Distribution Office, Department of Mines and Technical Surveys, Ottawa.

REFERENCE

Roads: hard surface, all weather (more than 2 lanes; 2 lanes or more); loose surface, all weather (less than 2 lanes); wagon; cart track (less than 2 lanes); Railway: normal gauge (multiple track; single track; abandoned); Boundaries: international; provincial; Indian reserve, park, etc.; township, surveyed; township, unsurveyed; Section line; Trail or portage; Contours: elevation; depression; approximate; Spot elevation (in feet); Power transmission line; Telephone line; Boundary monument; Astronomical position; Horizontal control point; City or large town; Town; Village or settlement; Post office; School; Church; Streams: intermittent or dry; indefinite; Irrigation canal or ditch; Rapids; falls; Aerodrome; Landing ground; Intermittent lake; Marsh or swamp; Sand, gravel or mud; Wooded areas; Seaplane base; Seaplane anchorage

RED DEER

ALBERTA

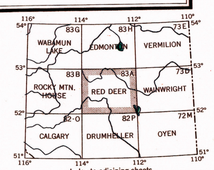
WEST OF FOURTH MERIDIAN

Scale 1:250,000

1 Inch to 4 Miles Approximately

Miles 5 0 5 10 15 20 Miles

Kilometres 5 0 5 10 15 20 25 30 Kilometres



Index to adjoining sheets

GRID ZONE DESIGNATION 12U

100,000 M SQUARE IDENTIFICATION: TP UP VP / TN UN VN; 580; 30 40

TO GIVE A REFERENCE TO NEAREST 1000 METRES

EXAMPLE: CHURCH

SQUARE: Read letters of 100,000 m. square UP

EASTING: Read number on grid line immediately to left of point 4. Estimate tenths of a square from this line eastward to point. 2/42

NORTHING: Read number on grid line immediately below point 3. Estimate tenths of a square from this line northward to point. 1/31

MILITARY GRID REFERENCE UP4231 (to nearest 1,000 metres)

If reporting beyond 10° in any direction, prefix Grid Zone Designation as: 12UUP4231

TEN THOUSAND METRE
UNIVERSAL TRANSVERSE MERCATOR GRID
ZONE 12

RED DEER
83 A
EDITION 1 ASE

NATIONAL TOPOGRAPHIC SYSTEM

1:250,000

CANADA

FIRST EDITION

SHEET 83 A

Refer to this Map as:- 83 A EDITION 1 ASE SERIES A502

RED DEER

ALBERTA

WEST OF FOURTH MERIDIAN

Scale 1:250,000

1 Inch to 4 Miles Approximately

Miles 5 0 5 10 15 20 Miles

Kilometres 5 0 5 10 15 20 25 30 Kilometres

Universal Transverse Mercator Projection

Contour interval 100 Feet
Elevations in Feet above Mean Sea Level
North American Datum 1927.

Produced and printed by the SURVEYS AND MAPPING BRANCH, DEPARTMENT OF MINES AND TECHNICAL SURVEYS, 1958

THE DECLINATION OF THE COMPASS NEEDLE 1955

The declination of the compass needle at any place along a red line is the declination given for that red line. If other places the declination is between those given on the neighbouring red lines; thus at the place marked A, the declination is between 23°00'E and 23°30'E. The declination of the compass needle is decreasing 41.2 minutes annually.

REFERENCE

Roads: more than 2 lanes; 2 lanes or more; 2 lanes; less than 2 lanes; less than 2 lanes; dry weather
hard surface, all weather
loose surface, all weather
wagon; cart track
Railway: normal gauge — multiple track; station; single track; flagstop; abandoned
Boundaries: international; provincial; Indian reserve, park, etc.; township, surveyed; township, unsurveyed; Section line
Contours: elevation; depression; approximate; Spot elevation (in feet); Power transmission line; Telephone line

REFERENCE

City or large town; Town; Village or settlement
Streams: intermittent or dry; indefinite; Irrigation canal or ditch; Rapids; falls; Aerodrome; Landing ground
Post office; School; Church
Boundary monument; Astronomical position; Horizontal control point
Intermittent lake; Marsh or swamp; Sand, gravel or mud; Wooded areas; Seaplane base; Seaplane anchorage

GRID ZONE DESIGNATION 12U

100,000 M. SQUARE IDENTIFICATION: TP UP VP / TN UN VN; 580; 30 40

TO GIVE A REFERENCE TO NEAREST 1000 METRES

EXAMPLE: CHURCH

SQUARE: Read letters of 100,000 m. square UP

EASTING: Read number on grid line immediately to left of point. Estimate tenths of a square from this line eastward to point. 42

NORTHING: Read number on grid line immediately below point. Estimate tenths of a square from this line northward to point. 31

MILITARY GRID REFERENCE UP4231 (to nearest 1,000 metres)

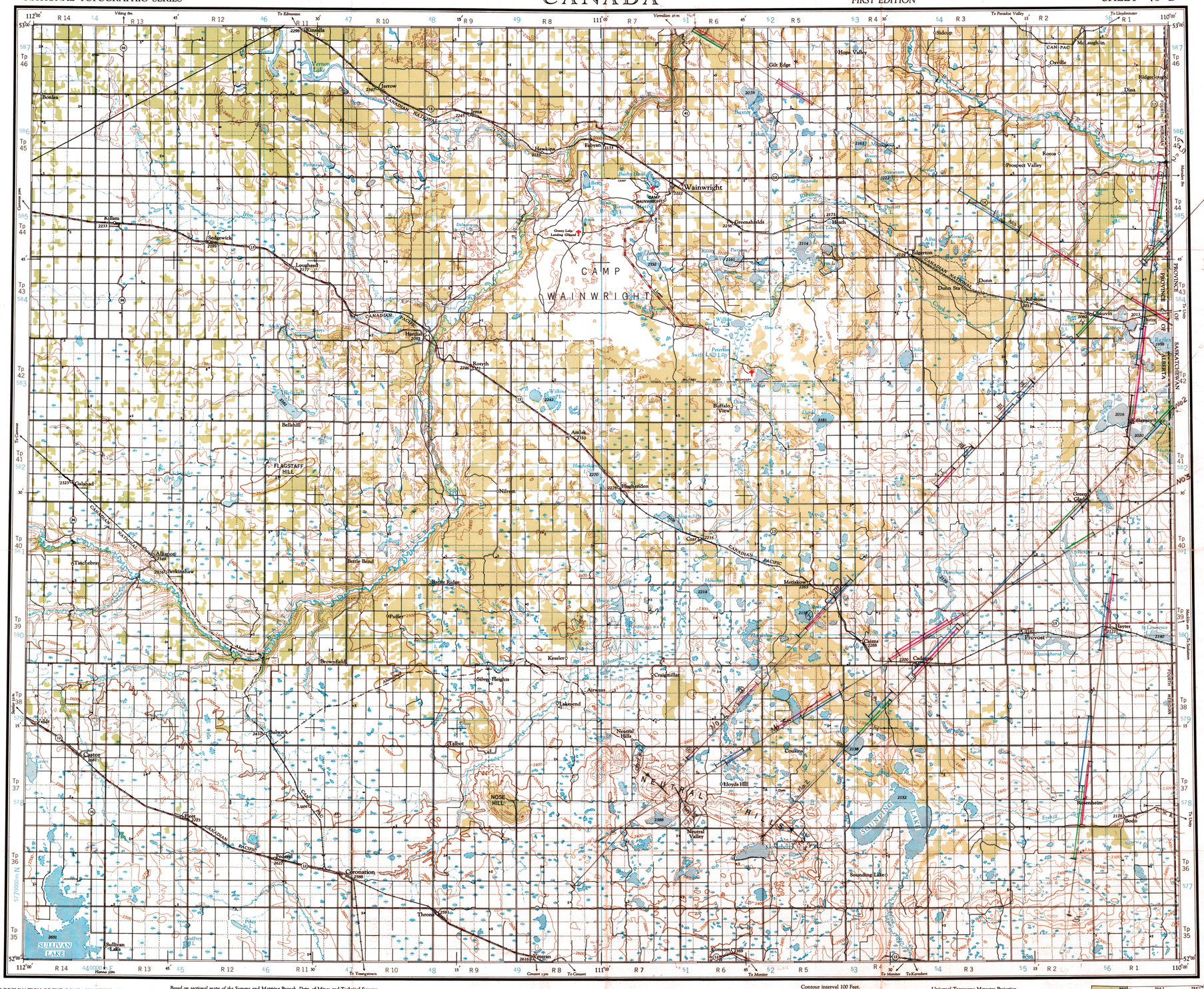
If reporting beyond 18° in any direction, prefix Grid Zone Designation as: 12 UUP4231

TEN THOUSAND METRE UNIVERSAL TRANSVERSE MERCATOR GRID ZONE 12

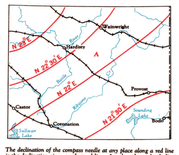
Index to adjoining sheets: 83G, 83H, 73E; WABAMUN LAKE, EDMONTON, VERMILION; 83B, 83A, 73D; ROCKY MTN. HOUSE, RED DEER, WAINWRIGHT; 82O, 82P, 72M; CALGARY, DRUMHELLER, OYEN

RED DEER 83 A

EDITION 1 ASE



THE DECLINATION OF THE COMPASS NEEDLE, 1952



The declination of the compass needle at any place along a red line is the declination given on that red line. At other places the declination is between those given on the neighbouring red line; thus at the place marked A, the declination is between N 22° 30' E. and N 23° 00' E. The easterly declinations of the compass needle are decreasing 3 minutes annually.

Based on sectional maps of the Surveys and Mapping Branch, Dept. of Mines and Technical Surveys
Aerial photography by the R.C.A.F. 1947.
Recompiled, drawn and reproduced by the Army Survey Establishment R.C.E.
Department of National Defence, 1951-53.

REFERENCE

Road, Loose Surface, All Weather	More than 2 Lanes / 2 Lanes
" Loose Surface, Less than a Lanes	All Weather / Dry Weather
Trail	
Railway, Multiple Track	
" Single Track	
Boundary, International	
" Province or State	
" County or District	
" Township	
" Reservations, Indian, Military, Park, etc.	

WAINWRIGHT
ALBERTA

Scale 1 : 250,000
1 Inch to 4 Miles Approximately

Miles 0 5 10 15 20 Miles
Kilometres 0 5 10 15 20 25 30 Kilometres

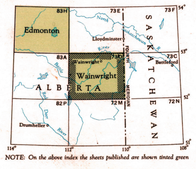
The general public may obtain copies of this map from the Map Distribution Office, Dept. of Mines and Technical Surveys, Ottawa.

Contour interval 100 Feet.
All Elevations in Feet above Mean Sea Level.

Universal Transverse Mercator Projection.

REFERENCE

Triangulation Station	Spot Elevation, in feet 257
Contours, Elevation	Wooded Areas
" Depression	Swamp or Marsh
" Approximate	
Church, School	
Stream, Intermittent	W.L. 241
Dam	Ferry, Mud, Sand
Falls	Navigation Light
Airport or airfield	Landing ground



NOTE: On the above Index the sheets published are shown tinted green

GRID ZONE DESIGNATION 12 U
100,000 M. SQUARE IDENTIFICATION: VP WP / VN WN

IGNORE the SMALLER figures of any grid number. these are for finding the full coordinates. Use ONLY the LARGER figures of the grid number. example 460,000

TO GIVE A STANDARD REFERENCE ON THIS SHEET TO NEAREST 1000 METRES

SAMPLE POINT: SCHOOL

1. Read letters identifying 100,000 metre square in which the point lies
2. Locate first VERTICAL grid line to LEFT of point and read LARGE figures labeling the line either in the top or bottom margin, or on the line itself. Estimate tenths from grid line to point.
3. Locate first HORIZONTAL grid line BELOW point and read LARGE figures labeling the line either in the left or right margin, or on the line itself. Estimate tenths from grid line to point.

	VP
	9
580	6
50	0
	6

SAMPLE REFERENCE: VP9606
If reporting beyond 10" in any direction, prefix Grid Zone Designation as 12UVP9606

TEN THOUSAND METRE
UNIVERSAL TRANSVERSE MERCATOR GRID
ZONE 12

WAINWRIGHT ALBERTA
SHEET 73 D
FIRST EDITION

NATIONAL TOPOGRAPHIC SYSTEM 1:250,000 **CANADA** FIRST EDITION SHEET 73 E

Refer to this map as: 73 E EDITION 1 ASE SERIES A 502

VERMILION

ALBERTA

WEST OF FOURTH MERIDIAN

Scale 1:250,000

1 Inch to 4 Miles Approximately

Transverse Mercator Projection

Contour Interval 100 Feet
Elevations in Feet above Mean Sea Level
North American Datum 1927.

Produced and printed by the SURVEYS AND MAPPING BRANCH, DEPARTMENT OF MINES AND TECHNICAL SURVEYS, 1959.

THE DECLINATION OF THE COMPASS NEEDLE 1959

The declination of the compass needle at any place along a red line is the declination given on that red line. At other places the declination is between those given on the neighbouring red lines; thus at the place marked A, the declination is between 22°00'E and 23°00'E. The declination of the compass needle is decreasing 5.1 minutes annually.

REFERENCE

Roads:
hard surface, all weather — more than 2 lanes / 2 lanes or more
loose surface, all weather — 2 lanes / 1 lane
wagon; cart track — Trail or portage
Railway: normal gauge — multiple track / station; single track / flagstop; (Abandoned)
Boundaries:
international
provincial
Indian reserve, park, etc.
township, surveyed
township, unsurveyed
Surveyed line
Contours: elevation
depression
approximate
Spot elevation (in feet) 2550
Power transmission line
Telephone line

REFERENCE

City or large town
Town
Village or settlement
Streams: intermittent or dry; indefinite
Irrigation canal or ditch
Rapids, falls
Airport
Airfield
Post office P
School
Church
Boundary monument
Astronomical position
Horizontal control point
Intermittent lake
Marsh or swamp
Sand, gravel or mud
Forest
Seaplane base
Seaplane anchorage

Index to adjoining sheets: TAWATINAW, SAND RIVER, WATERHEN RIVER, EDMONTON, VERMILION, ST. WALBURG, RED DEER, WAINWRIGHT, BATTLEFORD

GRID ZONE DESIGNATION 12U

100,000 M. SQUARE IDENTIFICATION: VQ/WQ / VP/WP

TO GIVE A REFERENCE TO NEAREST 1000 METRES

EXAMPLE: SCHOOL

SQUARE: Read letters of 100,000 m. square — VQ

EASTING: Read number on grid line immediately to left of point; Estimate tenths of a square from this line eastward to point. — 98

NORTHING: Read number on grid line immediately below point; Estimate tenths of a square from this line northward to point. — 29

MILITARY GRID REFERENCE (to nearest 1,000 metres) VQ9829

If reporting beyond 18° in any direction, prefix Grid Zone Designation as: 12UVQ9829

TEN THOUSAND METRE UNIVERSAL TRANSVERSE MERCATOR GRID ZONE 12

VERMILION 73E EDITION 1

CANADA

NATIONAL TOPOGRAPHIC SERIES

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

FIRST EDITION

CANADA SHEET 73 L

Refer to this Map as:- 73 L EDITION 1 ASE SERIES A502

SAND RIVER

ALBERTA

WEST OF FOURTH MERIDIAN

Scale 1:250,000

1 Inch to 4 Miles Approximately

PRELIMINARY MAP

Produced by the Surveys and Mapping Branch, Department of Mines and Technical Surveys, 1953, from air photographs taken in 1946 and 1949. Printed by the Army Survey Establishment, R.C.E., Department of National Defence, 1955.

Universal Transverse Mercator Projection.

Elevations in Feet above Mean Sea Level North American Datum 1927.

THE DECLINATION OF THE COMPASS NEEDLE 1954

The declination of the compass needle at any place along a red line is the declination given on that red line. At other places the declination is between those given on the neighbouring red lines; thus at the place marked **A** the declination is between 22°-30'E and 23°-30'E. The declination of the compass needle is decreasing 5' annually.

REFERENCE

Road, Hard Surface, All Weather — More than 2 Lanes; 2 Lanes; Route No.; Less than 2 Lanes

Road, Loose Surface — All Weather; All Weather; Dry Weather

Wagon Road, Cart Track, etc. — 2 Lanes or more; Less than 2 Lanes; Footpath or Trail

Railway, Standard Gauge — Multiple Track; Single Track; Abandoned

Boundary, International — Station; Siding; Boundary Marker

Boundary, Provincial — Astronomical Position

Boundary, Indian Res., Park, etc. — Horizontal Control Point

Boundary, Township or Settlement — Spot Elevation, (in feet)

Boundary, Township, Unsurveyed — Power Transmission Line

Section Line — Telephone or Telegraph Line

REFERENCE

City or Large Town — Post Office

Town — School

Village or Settlement — Church

Stream, Intermittent or Dry — Lake, Intermittent

Stream, Indefinite or Unsurveyed — Lake or Pond, Dry

Irrigation Canal or Ditch — Sand, Gravel or Mud

Rapids and Falls — Edge of Valley

Marsh or Swamp — Wooded Areas

Airport or Airfield — Seaplane Base

Landing Ground — Seaplane Anchorage

Miles 5 0 5 10 15 20 Miles

Kilometres 5 0 5 10 15 20 25 30 Kilometres

Index to Adjoining Sheets

PELICAN 83P; WINEFRED LAKE 73M; DILLON 73N; TAWATINAW 83H; SAND RIVER 73L; WATERHEN RIVER 73K; EDMONTON 83I; VERMILION 73E; ST. WALBURG 73F

GRID ZONE DESIGNATION 12U

100,000 M SQUARE IDENTIFICATION: VR WR / VQ WQ; 600; 50

IGNORE the SMALLER figures of any grid number. these are for finding the full coordinate. Use ONLY the LARGER figures of the grid number. example 4 40000

TO GIVE A STANDARD REFERENCE ON THIS SHEET TO NEAREST 1000 METRES

SAMPLE POINT: SCHOOL

1. Read letters identifying 100,000 metre square in which the point lies.
2. Locate first VERTICAL grid line to LEFT of point and read LARGE figures labeling the line either in the top or bottom margin, or on the line itself. Estimate tenths from grid line to point.
3. Locate first HORIZONTAL grid line BELOW point and read LARGE figures labeling the line either in the left or right margin, or on the line itself. Estimate tenths from grid line to point.

SAMPLE REFERENCE: WQ 27 99 — WQ2799

If reporting beyond 18° in any direction, prefix Grid Zone Designation as: 12UWQ2799

TEN THOUSAND METRE UNIVERSAL TRANSVERSE MERCATOR GRID ZONE 12

SAND RIVER 73L EDITION 1

Appendix 2 – Glossary and References

The following is a list of geological and hydrogeological terms that may not be common to the average reader but are found throughout the text and should be used in context with this report.

C Electrical conductivity measured from an open water source in the field. It is used as an indication of salinity. Measured in micromhos/metre.

T Temperature in degrees Fahrenheit.

Q Flow volume observed or measured in imperial gallons per minute.

Baseflow The groundwater contribution to a stream (Fetter, 1994, p. 5).

Dip The direction in which the sedimentary layers trend as a result of geological processes.

Discharge **"…**the removal of water from the saturated zone across the water-table surface, together with the associated flow toward the water table within the saturated zone." (Freeze and Cherry, 1979, p. 211)

Flowing Seismic Shothole A hole drilled or dug into the ground where explosives are placed in order to provide an energy release which will travel through the earth and back to a seismic receiver. Water may flow from this hole if the bottom of the hole is below the water table or if a confining layer is breached allowing water from the confined aquifer to be released.

Groundwater System Refers to groundwater flow systems which are "a family of flow lines connecting the whole or part of a recharge area with the whole or part of a discharge area." (Tóth, 2009, p. 252). The flow systems may be local, intermediate, or regional in nature and are relative terms which reflect the residence time of groundwater. A local system will have a shorter residence time than a regional system.

Permeability The property or capacity of a porous rock, sediment, or soil for transmitting a fluid; it is a measure of the relative ease of fluid flow under unequal pressure and is a function only of the medium (Jackson, 2005, p. 483

Phreatophyte Plants that "can live with their roots below the water table and they extract their moisture requirements directly from the saturated zone." They occur in groundwater discharge areas (Freeze and Cherry, 1979, p. 201).

Porosity The ratio of void space to the total volume of the medium.

Recharge "…the entry into the saturated zone of water made available at the water-table surface, together with the associated flow away from the water table within the saturated zone." (Freeze and Cherry, 1979, p. 211).

Scree slope Unconsolidated deposits at the base of a slope or cliff face which have fallen from the rock/sediment exposure.

Seepage Diffuse discharge of water, usually from unconsolidated sediments such as sand and gravel or from loose soil (Kresic and Stevanovic, 2010, p. 31).

Soap hole **"**Liquified part of the land surface characterized by local weakness of limited areal extent underlain by a viscous admixture of sand, silt, clay and water, brought about by upward moving groundwater. It can have mounded, hollowed, or flat surface, which may change in time." (Tóth, 2009, p. 257)

Spring "A spring is a location at the land surface where groundwater discharges from the aquifer, creating a visible flow." (Kresic and Stevanovic, 2010)

Strike A direction perpendicular to the dip of the geological layers.

Travertine Calcium carbonate deposits at or near the source of a spring as a result of changes in pressure, water chemistry and temperature when the spring water is exposed to the atmosphere.

References

Fetter, C. W. (1994): Applied hydrogeology; Prentice Hall, Upper Saddle River, N.J., 691 p.

Freeze, R. A. and Cherry, J. A. (1979): Groundwater; Prentice Hall, Englewood Cliffs, N.J., 604 p.

Kresic, N. and Stevanovic Z. (2010): Groundwater hydrology of springs; Elsevier, N.Y., 573 p.

Neuendorf, K. K. E., Mehl, J. P. and Jackson J. A. (2005): Glossary of geology (5th Edition); American Geological Institute, Alexandria, Virginia, 779 p.

Tóth, J. (2009): Gravitational systems of groundwater flow: theory, evaluation, utilization; Cambridge University Press, 310 p.